Institutional investors in the market for single-family housing: Where did they come from, where did they go?

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Abstract

This paper analyzes the entry of institutional investors into the single family rental market in the aftermath of the Great Recession. I show that their entry is an equilibrium response to tightened household funding constraints, driven by an increase in mortgage lending standards and declining real interest rates. Neighborhoods that institutional investors enter experience significant declines in housing affordability and home-ownership rates. A stylized model of local housing markets with funding constrained households and an unconstrained outside investor generates predictions consistent with my empirical evidence.

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1 Introduction

In the decade following the Great Recession institutional investors entered the market for single family rental housing, buying substantial numbers of single family homes in numerous housing markets across the United States. In this paper I analyze the causes of institutional investor entry into the single family rental market, as well as its long-term impact on affected neighborhoods. I employ a instrumental variables (IV) approach to show that both the *timing* and *location* of institutional investor activity is driven by their expected excess returns on single family housing: Institutional investors entered into the single family rental market *when* expected excess returns were high in the aggregate and selectively seek out neighborhoods *where* expected excess returns are high in particular. Intuitively, their universal absence prior implies that their outside options, the universe of financial securities typically traded by institutional investors, must have dominated investing in single family housing, typically traded by households as owner-occupied residence or rental properties owned by local landlords (Levy (2022)).

Figure 1: Expected excess returns on single family housing and outside options

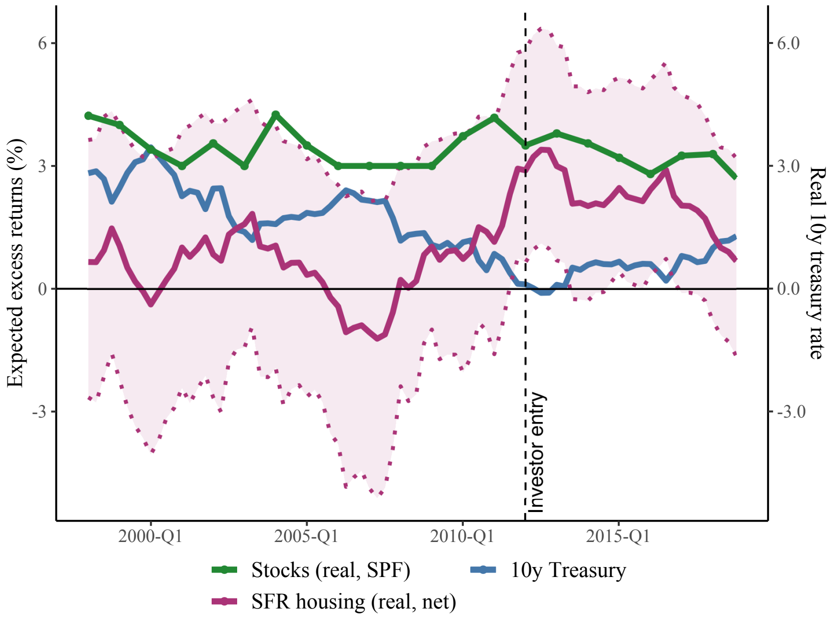


Figure plots median, 10th and 90th percentile of (real) expected excess returns after operating costs on single family housing across neighborhoods in red; Consensus estimate of (real) expected excess returns on stocks from Survey of Professional Forecasters in green; real 10-year treasury yield estimated by the Cleveland Federal Reserve in blue.

Conversely, this implies that households, the incumbent actors in the single family housing market, must have priced single family housing higher than institutional investors, or else this

segmentation would never have occurred. Intuitive examples why such discrepancies might exist are non-pecuniary benefits of home-ownership (see e.g. Kaplan et al. (2020)) and operating costs of outside investors (Demers and Eisfeldt (2022)).

What explains the rise in expected excess returns? If households are sufficiently funding constrained, this can distort the way in which they price homes and raise expected excess returns to the point where institutional investors enter. This is precisely what happened in the aftermath of the housing bust: Increasing lending standards and a decline in the risk-free rate tightened household funding constraints, causing expected excess returns to increase. Intuitively, neighborhoods with a higher population share of marginal borrowers were more exposed to increasing lending standards, experienced stronger tightening of household funding constraints and exhibited higher expected excess returns. In my sample period from 2006 to 2018 this mechanism can explain over 30% of the unconditional variation in expected excess returns and over 65% of variation *within* neighborhoods. I use these findings to instrument for expected excess returns in an IV regression of institutional investor activity onto expected excess returns and find that a 1pp increase in expected excess returns increases the probability of institutional investor activity by 4.2pp.

I proceed to use the backed out probability of institutional investor activity as control variable in a differences-in-differences study of how institutional investor entry affects housing affordability. This allows me to compare neighborhoods *conditional* on the implied probability of institutional investor entry, which effectively acts as a propensity score. I find that affordability of both rents and house prices decreases substantially. This decline in affordability goes in hand with a contemporaneous decline in home-ownership rates suggesting that in equilibrium institutional investors marginally displace homeowners and not incumbent landlords. The population of affected neighborhoods is younger, poorer and more diverse, suggesting that the entry of institutional investors does not affect all households equally.

The returns to institutional investor activity are substantial. Within a given quarter neighborhoods in which institutional investors are active realize 2.7pp higher excess returns p.a. over the next 3 years relative to neighborhoods that do not.

Literature These findings place my paper at the intersection of several strands of research within the literature on Housing, Macroeconomics and Finance.

Inherently, this paper builds on a large body of research that studies the housing boom of '02-'06 and the Great Recession that followed. From '02-'06, U.S. house prices experienced pronounced growth, before going through a prolonged decline that bottomed out in early 2012. The literature has identified two key drivers of the housing boom: An expansion of credit supply (Mian and Sufi (2011), Mian and Sufi (2021)), as well as an increase in optimism about house prices as suggested by Adelino et al. (2017) and Kaplan et al. (2020). The extent to which each of these forces is responsible for the housing boom remains a subject of ongoing research. Kaplan et al. (2020) show evidence in favor of the expectations hypothesis, while Greenwald and Guren (2020) find that credit supply expansion explains a substantial part of the increase in price-rent ratios during the housing boom. Common to both views is that available funds at the disposal of households increased - either because the credit supply curve shifted outward exogenously, or because lenders endogenously adjusted their supply of credit due to more optimistic expectations about future housing demand.

In contrast to this literature, the focus of my work is on the aftermath of the housing bust and the effects of subsequent credit *rationing*. The nature of this credit rationing is documented, for instance, by D'Acunto and Rossi (2021), who show that from 2011 onward U.S. mortgage lenders engaged in regressive mortgage credit redistribution away from households taking out mortgages beneath the conforming loan limit towards households taking out larger and safer jumbo loans. I show that another facet of credit rationing was an increase in mortgage lending standards. This is reflected in the credit scores of approved mortgage applicants, which markedly increased between 2006 and 2012, and further corroborated by the Federal Reserve's Senior Loan Officer Opinion Survey. I show that the entry of institutional investors into the single family housing market can be traced back to this increase in lending standards, the contemporaneous decline in real interest rates and their effect on expected excess returns.

My underlying mechanism follows similar intuition to the work of Black (1972) showing that borrowing constraints distort the unconstrained Capital Asset Pricing Model and flatten the Capital Market Line, dampening the relationship between risk and expected excess returns. Frazzini and Pedersen (2014) construct a trading strategy around this intuition that trades on

funding constraints to generate excess returns that exceed compensation for bearing risk. Analogous intuition can rationalize the entry institutional investors into the market for single family housing. I show that in contrast to a classical asset pricing framework in which expected excess returns are compensation for house price risk, expected excess returns on single family housing are driven by variation in household funding constraints that depend on the prevailing regime of lending standards and interest rates.[1] Neighborhoods where household funding constraints are tight (slack) exhibit high (low) real expected excess returns.

This connects my paper to a broader and more general literature on the asset pricing of residential real estate and the role of housing in household and investor portfolios. The majority of single family housing stock serves as primary residence of owner-occupant households, even though for many households this entails concentrating a large fraction of their net worth into a single illiquid asset exposed to substantial non-diversifiable risk (see, e.g. Piazzesi and Schneider (2016)). I argue that this must imply that the value of housing services that unconstrained households derive from home ownership exceeds the value of rental cash flows that accrue to an investor. Indeed, the most direct evidence of this is the historical absence of institutional investors from this market and their historical presence in virtually all other asset classes, including other forms of real estate.

In work closely related to this paper Demers and Eisfeldt (2022) investigate the historical *realized* total returns to single family rentals as an asset class over a long time horizon and construct a city level panel from 1986 to 2014 to estimate the *average* returns to single family rentals and time-varying *realized* net rental yields and appreciation gains. This exercise is inherently backward-looking and finds that the nominal total net return to single family rentals over this time period averages around 8.5%, composed equally of rental yields and appreciation, similar in size to the average return on equities. Net rental yields are comparatively stable over time and peak in 2000, 12 years prior to the entry of institutional investors into the single family rental market. My work corroborates these findings, but centers around *expected* excess returns which vary substantially across time and geographies, are driven by household funding constraints and real risk-free rates and *can* explain the entry of institutional investors.

[1]Hartman-Glaser and Mann (2021) find a similar pattern in which higher volatility is not compensated for by higher housing returns

Lastly, this paper also adds to the literature on the emergence of new actors in the U.S. housing market more broadly. Buchak et al. (2020) examine the rise of iBuyers as dealer-intermediaries attempting to provide liquidity in housing markets. Favilukis and Van Nieuwerburgh (2021) investigate the emergence of out-of-town home buyers and find a negative welfare effect that disproportionately affects renters, similar to the findings in this paper. In work most directly related to this paper, Mills et al. (2019) provide descriptive evidence on the activity of institutional investors between 2012 and 2014 and suggest three potential channels that may have led to their emergence - housing supply, tight mortgage financing and technological advances. To the extent that our analysis overlaps, my findings corroborate the descriptive findings of Mills et al. (2019). My work shows that of the three proposed channels only mortgage financing contributes meaningfully to expected excess returns and additionally highlights the importance of real interest rates and outside investment opportunities. Further, new and longer data coverage combined with recent advances in the DiD literature allow me to investigate the medium and long term impact of institutional investor activity on incumbent households, which the narrow sample window of Mills et al. (2019) prohibits. I show that especially over longer time horizons the affordability of both house prices and rents significantly declines in neighborhoods that institutional investors entered.

The remaining structure of this paper is as follows: Section 2 provides intuition through a stylized model of local housing markets with funding constrained households and outside investors that are unaffected by funding constraints adapted from Frazzini and Pedersen (2014). I derive necessary and sufficient conditions for investor absence and entry, placing bounds on household funding constraints as function of household funds, access to leverage and the risk-free rate. Section 3 analyzes the entry of institutional investors empirically. I extract estimates of expected excess returns for each neighborhood and quarter in my sample from a Campbell and Shiller (1988) decomposition of local price-rent ratios adapted from Campbell et al. (2009). I show that the time series and cross-section of expected excess returns on single family housing can be explained by variation in household funding constraints across time and geographies. Using the population share of marginal borrowers as instrument I derive unbiased estimates of how expected excess returns shape institutional investor activity. Section 4 investigates how households and investors fare after institutional investor entry. Section 5 discusses my findings

and other channels before section 6 concludes.

2 Illustrative Model

A stylized model of a single neighborhood n is populated by a unit mass of representative households h and deep pocketed outside investors I that each solve a mean-variance portfolio optimization problem with a fixed supply of housing H^* with unit price P_t^H and rents δ_{t+1}^H paid at the end of each period t. Expected next period house prices follow a conditional distribution with variance σ_H^2 and mean $\mathbb{E}_t^j\left[P_t^H\right]$, for $j \in \{h, I\}$. Detailed solutions and proofs of the propositions that follow are in section E of the appendix.

Household problem The representative households are each endowed with funds ω_{ht}^n and choose their position in housing x_t^H subject to a short sales and borrowing constraint in form of a down-payment requirement $0 \leq x_{ht}^H P_t^H \leq \frac{\omega_{ht}^n}{m_{ht}^n}$. Households can save and borrow at the risk-free rate short-term deposits. Their portfolio choice problem is given by a constrained mean variance optimization problem with constant absolute risk aversion A_h in which households may derive non-pecuniary benefits $\nu \geq 0$ from home ownership.

$$\max_{x_{ht}^H \geq 0} x_{ht}^H \left(\mathbb{E}_t^h\left[P_{ht+1}^H\right] + (1+\nu)\delta_{t+1}^H - R_{t+1}^f P_t^H\right) - \frac{A_h}{2}(x_{ht}^H)^2\sigma_H^2 - \psi_{ht}^n\left[x_{ht}^H P_t^H - \frac{\omega_{ht}^n}{m_{ht}^n}\right]$$

Investor problem The representative investors with constant absolute risk aversion A_I manages funds on behalf of households *outside* the local neighborhood z and is unaffected by down-payment requirements but entails costs τ from operating as an outside landlord. Additionally, she has access to an outside asset representative of the universe of financial investment assets that is in fixed supply S^*. She solves an analogous portfolio choice problem

$$\max_{x_{It}^S \geq 0, x_{It}^H \geq 0} \mathbb{E}_t^I\left[\begin{pmatrix} x_{It}^S \\ x_{It}^H \end{pmatrix}' \left[\begin{pmatrix} P_{t+1}^S \\ P_{t+1}^H \end{pmatrix} + \begin{pmatrix} \delta_{t+1}^S \\ (1-\tau)\delta_{t+1}^H \end{pmatrix} - R_{t+1}^f \begin{pmatrix} P_t^S \\ P_t^H \end{pmatrix}\right]\right] - \frac{A_I}{2}\begin{pmatrix} x_{It}^S \\ x_{It}^H \end{pmatrix}' \Omega \begin{pmatrix} x_{It}^S \\ x_{It}^H \end{pmatrix}$$

where Ω denotes the covariance matrix between house prices and the outside asset. Since only the investor has access to the outside asset, she holds the total supply S^* which serves to normalize her outside option. The open question is whether she holds the outside asset

exclusively or whether she also holds some fraction of the local housing market, which depends on household demand for housing, the outside asset and risk-free rate R^f_{t+1}, as well as Ω. For the purpose of exposition I assume that $\Omega = \begin{pmatrix} \sigma_S^2 & 0 \\ 0 & \sigma_H^2 \end{pmatrix}$. If house prices are in fact positively (negatively) correlated with the price of the outside asset, the investor's position in housing is lower (higher).

Equilibrium Equilibrium is a collection of household and investor positions $\{x^H_{ht}, x^H_{It}, x^S_I\}$ and prices P^H_t, P^S_t such that

(i) Representative households and investors solve their respective portfolio optimization problems given household funds ω^n_{ht} subject to their down-payment constraint m^n_{ht} and short sales constraints

(ii) Housing and stock markets clear given expectations of next period prices $\mathbb{E}^h_t\left[P^H_{t+1}\right]$, $\mathbb{E}^I_t\left[P^H_{t+1}\right], \mathbb{E}^I_t\left[P^S_{t+1}\right]$ and rent or dividend levels $\delta^H_{t+1}, \delta^S_{t+1}$ such that

$$H^* = \int_0^1 x^H_{ht}(P^H_t)dh + x^H_{It}(P^H_t)$$
$$S^* = x^S_{It}(P^S_t)$$

Proposition 1 *A segmented equilibrium in which households own the entirety of the housing stock can only occur if*

$$(\nu + \tau)\delta^H_{t+1} + \Delta^H_{hI} > A_h \sigma^2_H H^* \tag{1}$$

where $\Delta^H_{hI} \equiv \mathbb{E}^h_t\left[P^H_{t+1}\right] - \mathbb{E}^I_t\left[P^H_{t+1}\right]$.

Intuitively, if unconstrained households and the investor do not sufficiently disagree in their valuation of housing, both households and the investor always hold positive amounts of housing, even when households are unconstrained. The right hand side is equivalent to the premium that accrues to an unconstrained household as compensation for bearing house price risk. The left hand side consists of the difference between households' and the investor's value of rental cash flows, which can be interpreted as the relative costs of operating as landlord, and their differences in expectations of future house prices, with segmentation more (less) likely to occur if households

are more (less) optimistic than the investor. Under rational expectations household and investor expectations coincide. I discuss this and further implications of rational expectations at length in section 5.[2]

Provided that equation (1) holds, segmentation occurs as long as the total household funding constraint $\frac{\omega^n_{ht}}{m^n_{ht}}$ is sufficiently slack (or equivalently, if ψ^n_{ht} is sufficiently small, or if the investor's expected excess returns are sufficiently high).

Proposition 2 *If proposition 1 is satisfied, the equilibrium is segmented if and only if the household funding constraint is sufficiently slack, that is if*

$$\psi_{ht} < R^f_{t+1}\left[\frac{(\nu+\tau)\delta^H_{t+1} - \Delta^H_{Ih} - A_h\sigma^2_H H^*}{\mathbb{E}^I_t\left[P^H_{t+1}\right] + (1-\tau)\delta_{t+1}}\right]$$

which is equivalent to requiring that

$$\frac{\omega^n_{ht}}{m^n_{ht}} \geq \frac{H^*\left(\mathbb{E}^I_t\left[P^H_{t+1}\right] + (1-\tau)\delta^H_{t+1}\right)}{R^f_{t+1}} \tag{2}$$

In order to support a segmented equilibrium households need sufficient access to funds that their demand clears the market at a price above the point at which investors enter into the housing market. This implies that house prices P^H_t fall into two regions: A segmentation region in which house prices are determined by the household's first order condition and inequality (2) holds, and a pooling region in which segmentation breaks down and house prices are determined by the joint demand of funding constrained households and the investor, which I solve for in the appendix.

Inspecting proposition 2, investor activity is a decreasing function of the risk-free rate and the

[2]Rearranging equation (1) also allows to place a lower bound on $\nu+\tau$.

$$\nu+\tau > \frac{A_h\sigma^2_H H^*}{\delta^H_{t+1}} \approx H^* A_h \delta^H_{t+1} Var_t\left(\frac{P^H_{t+1}}{\delta^H_{t+1}}\right)$$

Normalizing $H^*=1$ and $A_h = \frac{2}{\omega^n_{ht}}$ to approximate a coefficient of relative risk aversion of 2, a back of the envelope calculation that sets ω^n_{ht} equal to the median U.S. household net worth in 2010, δ^H_{t+1} equal to the quarterly median rent in 2010 and $Var_t\left(\frac{P^H_{t+1}}{\delta^H_{t+1}}\right)$ equal to the median conditional variance of the quarterly price-rent ratio leads to

$$\nu+\tau \succcurlyeq .259$$

which accommodates both plausible estimates for maintenance costs on the order of 20-30% as well as estimates of non-pecuniary benefits of housing flows used, for example, in Kaplan et al. (2020).

total household funding constraint $\frac{\omega^n_{ht}}{m^n_{ht}}$, which itself depends on available household funds ω^n_{ht} and their borrowing constraint m^n_{ht}. All else equal, increasing the down-payment requirement directly tightens their funding constraint, while a decline in the risk-free rate lowers both households' and the investor's opportunity costs, making it more likely for the household to run into their funding constraint and the investor to enter. Due to the stylized two-period nature of the model necessary to derive closed form solutions the effect of changes in the risk-free rate is understated relative to a rational expectations model and my empirical findings. I discuss this further in section 5.

Using these results to derive testable predictions in the data, households are more likely to be funding constrained *when* the real risk-free rate is low, *where* households have lower wealth (ω^n_{ht} is low), *when and where* households are exposed to credit rationing (m^n_{ht} is high). This means that the time-series of risk-free rates and lending standards determine the *timing* of institutional investor entry, while cross-sectional variation in household funds and exposure to tightening lending standards determine the *location*.

The following section takes the qualitative model predictions to the data and shows that they are borne out empirically.

3 Empirical evidence on institutional investor entry

Data In order to verify my intuition I construct geography×quarter panels of institutional investor transactions and ownership of housing stock from the universe of CoreLogic housing deed records, which I restrict to properties marked as single family homes or duplexes and clean following the literature. Like Mills et al. (2019) I use SEC filings of subsidiaries by firms that are known actors in the single family rental market to match recorded buyer/seller names in the deeds records to parent companies. This limits the scope of my measurement, as it restricts my analysis to public firms that are required to file with the SEC or firms that do not act through subsidiaries. While this means that my measurement is a lower bound on the true extent of institutional investor activity, it allows me to cross-verify the nature of the actors I focus on. Appendix C provides further information on my construction of the data.

While the deeds data purportedly covers the universe of U.S. housing transactions from 1996

onward, the main limiting factor of my analysis is the availability of historical rental data, an obstacle that numerous researchers have encountered previously (Demers and Eisfeldt (2022)). I address this issue by making use of the CBRE Torto-Wheaton Same Store Rent index for multi-family housing units, the same data vendor used by Greenwald and Guren (2020), which covers 862 submarkets of 66 U.S. housing markets starting in 1996. Markets and submarkets are custom delineations specific to CBRE that are roughly equivalent to metro areas and neighborhoods or subdivisions in size[3]. Using their website it was possible to construct a zipcode-to-submarket crosswalk that allows me to aggregate other variables measured at the zipcode level up to the submarket level, which I use as main level of geographic observation throughout the paper. I supplement my panels of institutional investor activity with quarterly observations of neighborhood house and rental prices, aggregated credit bureau data, as well as income and demographic data from the IRS and Census. For the main body of my work I restrict myself to neighborhoods for which I observe data on all the variables relevant to my analysis, which limits my main sample to 792 neighborhoods across 65 cities.

Investor's expected excess returns I use my panel of house price and rental data to extract estimates of investor's expected excess returns on single family housing for each neighborhood n of city c and quarter q in my sample covering 792 neighborhoods across 65 housing markets over the time span from 1998 to 2018. I derive these estimates of investor's expected excess returns from a Campbell and Shiller (1988) decomposition of local rent-price ratios in a two step VAR procedure adapted from Campbell et al. (2009).

Given quarterly observations on real rents and house prices, the net returns on housing $R^{\pi}_{n,q+1}$ in neighborhood n from the view of an investor landlord are given by

$$R^{\pi}_{n,q+1} \equiv \frac{P_{n,q+1} + D_{n,q+1} - \tau(P_{n,q}, D_{n,q+1})}{P_{n,q}}$$

where $\tau(P_{n,q}, D_{n,q+1})$ denotes operating costs before taxes that I calculate following Demers and Eisfeldt (2022). Applying standard transformations in the style of Campbell and Shiller (1988) yields a decomposition of the real log net rent-price ratio that can be rearranged to

[3]For the purpose of clarity, the remainder of this paper uses the terms city and market interchangeably, while I exclusively refer to submarkets as neighborhoods

yield a term for the (weighted) sum of future real expected excess returns in terms of the log rent-price ratio and expectations of future risk-free rates and rental growth, *after* accounting for operating costs.

$$\mathbb{E}_q\left[\sum_{j=0}^{\infty}\rho_n^j rx_{n,q+j+1}^{\pi}\right] = dp_{n,q} + \mathbb{E}_q\left[\sum_{j=0}^{\infty}\rho_n^j \Delta d_{n,q+j+1}^{\pi}\right] - \mathbb{E}_q\left[\sum_{j=0}^{\infty}\rho_n^j r_{f,q+j+1}^{\pi}\right] - k_n$$

This term can be transformed into an expression for the (weighted) average of net expected excess returns on single family housing $\overline{rx}_{n,q}^{\pi}$ in neighborhood n and quarter q that I define as

$$\overline{rx}_{n,q}^{\pi} \equiv (1-\rho_n)\mathbb{E}_q\left[\sum_{j=0}^{\infty}\rho_n^j rx_{n,q+j+1}^{\pi}\right]$$

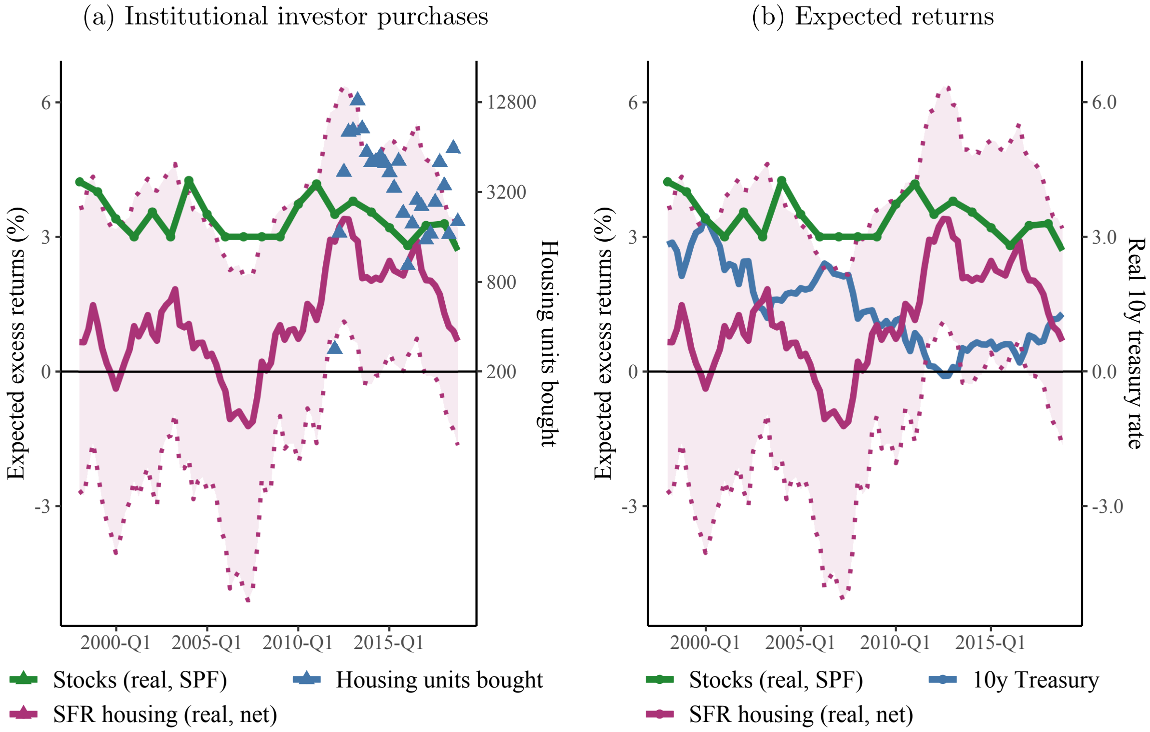
I back out estimates $\widehat{\overline{rx}}_{n,q}$ from a Vector Auto-Regression model adapted from Campbell et al. (2009) that incorporates expectations of future risk-free rates from the real yield curve, local labor market data and forecasts from the Survey of Professional Forecasters, where $\widehat{u}_{nq}$ denotes possible measurement error due to the constructed forecasts not necessarily coinciding with investor's actual forecasts that are unobserved. Appendix D.1 covers the estimation process of expected excess returns in detail.

$$\widehat{\overline{rx}}_{n,q}^{\pi} = (1-\rho_n)\left\{dp_{n,q} + \widehat{\mathbb{E}}\left[\sum_{j=0}^{\infty}\rho_n^j \Delta d_{n,q+j+1}^{\pi}\right] - \widehat{\mathbb{E}}_q\left[\sum_{j=0}^{\infty}\rho_n^j r_{f,q+j+1}^{\pi}\right] - k_n\right\} + \widehat{u}_{nq}$$

Entry timing The results of this exercise in figure 2 suggest that the *timing* of investor entry into the single family rental market is a response to an increase of expected excess returns on single family housing. Panel (a) plots expected excess returns on stocks and single family housing and shows that institutional investors enter into the market in 2012, as the gap between expected excess returns on stocks and single family rentals narrows to its lowest point in the time series. The convergence between expected returns on stocks and single family housing is mainly due to an increase in the expected returns on single family housing in the aftermath of the housing bust, as surveyed expected excess returns on stocks remain nearly constant. Panel (b) confirms that there is a strong negative relationship between expected excess return and the real risk-free rate.

However, while figure 2 shows a clear correlation between the *timing* of institutional investor activity and expected excess returns, it does not establish causality or speak to institutional investor activity in the cross-section, nor does it address the potential issue of measurement error induced by incorporating forecast data. I address these points in the following section by showing that expected excess returns are driven by household funding constraints which allows me to instrument for expected excess returns and derive unbiased estimates of institutional investors' response to changes in expected excess returns.

Figure 2: Time series of net expected excess returns on SFH



Figures plot median, 10th and 90th percentile of estimated (net) expected excess returns $\widehat{rx}^{\pi}_{nq}$ across neighborhoods in red and expected excess returns on stocks based on Survey of Professional Forecasters in green. Blue dots in panel (a) mark estimated quarterly purchase activity of institutional investors above 200 purchases. Panel (b) plots the real yield on 10 year treasuries estimated by the Cleveland Federal Reserve in blue.

Funding constraints and expected excess returns Section 2 illustrated that differences in valuation of housing services create a natural segmentation of the housing market that breaks down if household funding constraints are sufficiently tight (or equivalently expected excess returns are sufficiently high). In this section I demonstrate that household funding constraints as function of households' funds, their access to leverage and the real risk-free rate explain the

variation of expected excess returns across time and geographies. This result will allow me to instrument for expected excess returns in the following section.

My identification hinges upon the argument that funding constraints vary across time and neighborhoods, depending on the prevailing regime of interest rates and lending standards. Importantly, lending standards not only affect the intensive margin of households' available size of mortgages, but also the extensive margin of which households can take out mortgages at all. Figure A.1 illustrates this succinctly by contrasting changes in lending standards from the Federal Reserve Senior Loan Officer Opinion Survey with the credit scores of successful mortgage applicants, which increased from 620 to 680 between 2007 and 2012. Because households with credit scores between these bounds are likely to lose or gain access to credit depending on the prevailing regime of lending standards I call these households marginal borrowers. Intuitively, neighborhoods with a high population share of marginal borrowers should have experienced substantial credit rationing that translated into tightened funding constraints and increased expected excess returns.

Figure 3: Expected excess returns and marginal borrower population share

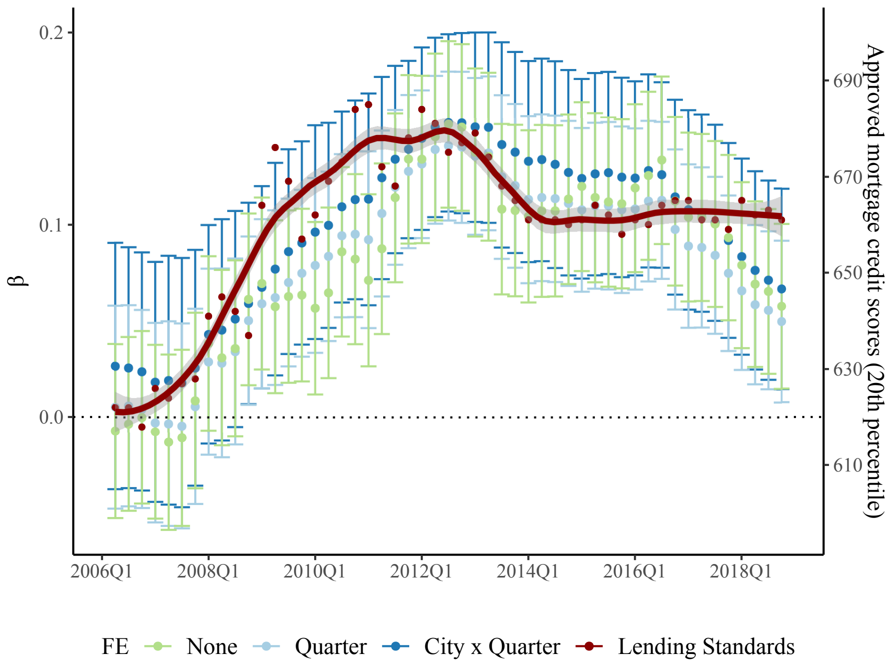


Figure shows quarterly regression coefficients β_q obtained from regressing estimated expected excess returns $\widehat{rx}^{\pi}_{nq}$ (in %) onto ex-ante neighborhood population share of marginal borrowers pop^{exp}_{n06q1} (in %), controlling for fixed effects and neighborhood controls $X_{n,q}$.

$$\widehat{rx}^{\pi}_{n,q} = \alpha_{(c,q)} + \sum_{q} \beta_q \; pop^{exp}_{n,06q1} \times 1_q + \gamma X_{n,q} + \varepsilon_{n,q}$$

Standard errors two-way clustered by city and calendar quarter.

I formally test this intuition in figure 3 by estimating quarterly regression coefficients β_q from regressing expected excess returns $\widehat{\widetilde{rx}}^{\pi}_{n,q}$ onto ex-ante marginal borrower population share $pop^{exp}_{n,06q1}$, city and quarter fixed effects $\alpha_{(c,q)}$ and controls $X_{n,q}$ that include volatility of excess returns on housing and neighborhood average adjusted gross income constructed from zipcode-level IRS statistics.

$$\widehat{\widetilde{rx}}^{\pi}_{n,q} = \alpha_{(c,q)} + \sum_q \beta_q \; pop^{exp}_{n,06q1} \times 1_q + \gamma X_{n,q} + \varepsilon_{n,q} \tag{3}$$

In 2006, the first year for which I observe credit scores and when lending standards were at their *lowest*, there is no statistically significant relationship between expected excess returns and marginal borrower population shares. In contrast, by 2012 a neighborhood with a 10 percentage point higher population share of marginal borrowers is associated with expected excess returns that are around 150 bps higher, even after controlling for quarter or city×quarter fixed effects.

I next take this intuition one step further and regress expected excess returns directly onto the initial population share of marginal borrowers pop^{exp}_{n06q1} interacted with the 20th percentile of approved mortgage applicants' credit scores $cred^{20}_q$ as proxy for time-varying lending standards, neighborhood income as proxy for households funds and the real risk-free rate, controlling for volatility of excess returns.

$$\widehat{\widetilde{rx}}^{\pi}_{nq} = \alpha_{(c,n,q)} + \beta_1 \; cred^{20}_q + \beta_2 \; pop^{exp}_{n,06q1} + \beta_3 \; cred^{20}_q \times pop^{exp}_{n,06q1} + \gamma X_{n,q} + \varepsilon_{n,q} \tag{4}$$

If expected excess returns are driven by funding constraints, we would expect the coefficient on the interaction term to be positive and the coefficients on income and the risk-free rate[4] to be negative.

Inspecting the baseline regression in column (1) and comparing two neighborhoods with initial marginal borrower population shares of 20% and 40% that are otherwise identical, an increase in my proxy for lending standards from one standard deviation below its mean to one standard deviation above[5] raises expected excess returns by 1.5pp in the former and by 3.01pp in the latter. Including the risk-free rate in column (2) has a significant and economically large effect

[4] provided that it is not absorbed by quarter-fixed effects

[5] equivalent to a change in lending standards that increases the 20th percentile of approved mortgage applicants' credit scores from 641 to 677

on expected excess returns that explains around 85% of the variation captured by the inclusion of quarter fixed effects in column (3).[6] The estimated coefficients on the interaction term and risk-free rate are stable across all levels of fixed effects. In specifications that do not control for geography fixed effects the estimated coefficients on income and volatility are negative and statistically significant. The negative coefficient on volatility contradicts classical asset pricing theory and further corroborates my mechanism and the importance of funding constraints. In appendix E.4.1 I show that if conditions (1) and (2) are satisfied the investor's expected excess returns are decreasing in volatility. Appendix D.2 details my procedure to construct volatility measures and confirms that there is no relationship between average volatility and expected excess returns. As a robustness check appendix table B.1 repeats this exercise using the rent-price ratio as dependent variable and finds qualitatively identical results.

Table 1: Explaining expected excess returns on single family housing

	Dependent variable:						
				$\widehat{rx}^{\pi}_{nq}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$cred^{20}_q$(standardized)	0.019	-1.301^{***}		0.003	-1.312^{***}		
	(0.144)	(0.157)		(0.158)	(0.176)		
pop^{exp}_{n06q1}	0.084^{***}	0.083^{***}	0.079^{***}				0.095^{**}
	(0.022)	(0.022)	(0.022)				(0.030)
$cred^{20}_q \times pop^{exp}_{n06q1}$	0.038^{***}	0.037^{***}	0.037^{***}	0.038^{***}	0.038^{***}	0.037^{***}	0.036^{***}
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)
$r^{f,\pi}_q$		-2.289^{***}			-2.283^{***}		
		(0.173)			(0.179)		
$avvol_n$	-0.104^{**}	-0.104^{**}	-0.105^{**}				0.067
	(0.033)	(0.033)	(0.033)				(0.099)
$\log(\text{Inc}^{\pi}_{n,q})$	-0.857^{**}	-0.886^{**}	-0.968^{**}	-0.009	-0.594	-3.008^{***}	-0.439
	(0.304)	(0.301)	(0.307)	(1.091)	(0.652)	(0.720)	(0.274)
Constant	9.425^{*}	11.860^{**}					
	(3.921)	(3.899)					
Observations	41,007	41,007	41,007	41,007	41,007	41,007	41,007
Adjusted R^2	0.312	0.382	0.395	0.798	0.869	0.885	0.559
Within R^2	0.312	0.382	0.194	0.475	0.659	0.125	0.196
Neighborhood FE	No	No	No	Yes	Yes	Yes	No
Quarter FE	No	No	Yes	No	No	Yes	No
City×Quarter FE	No	No	No	No	No	No	Yes
Note:							*p<0.05; **p<0.01; ***p<0.001

Table shows regression results from regressing quarterly estimated expected excess returns (in pp) onto marginal borrower population share (in pp) interacted with time series of 20th percentile of mortgage applicants credit scores using the full sample from 2006 to 2018.

$$\widehat{rx}^{\pi}_{nq} = \alpha_{(c,n,q)} + \beta_1\ cred^{20}_q + \beta_2\ pop^{exp}_{n,06q1} + \beta_3\ cred^{20}_q \times pop^{exp}_{n,06q1} + \gamma X_{n,q} + \varepsilon_{n,q}$$

Standard errors two-way clustered by city and calendar quarter.

[6] This is consistent with the strong negative covariance between expected excess returns and the risk-free rate first reported by Campbell et al. (2009). This relationship is not mechanical - if prices and the price-rent ratio were to freely adjust to a decline in the risk-free rate, expected excess returns would remain unaffected. That this is not the case is further evidence on the importance of funding constraints.

Expected excess returns and institutional investor activity These findings allow me to derive unbiased estimates of how expected excess returns shape institutional investor activity by instrumenting for expected excess returns using equation (4). I measure activity of institutional investors with a dummy variable $inv_{n,q}$ that takes the value 1 if the actors in question bought at least 1% of all the properties transacted in a neighborhood n in a given quarter q. I use a dummy variable instead of market shares or quantities to control for the fact that activity is frequently lumpy and total transaction volume varies across time and geographies.[7] Table 2 regresses investor activity $inv_{n,q}$ onto expected excess returns $\widehat{rx}^{\pi}_{n,q}$ instrumented using equation (4) and controls $X_{n,q}$ that include the real risk-free rate and volatility of excess housing returns, controlling for time and neighborhood fixed effects $\alpha_{(n,q)}$. Appendix table B.2 reports the corresponding OLS estimates that are qualitatively similar but smaller in magnitude, consistent with measurement error in the constructed forecasts. As a robustness check I instrument for the rent-price ratio instead of expected excess returns in appendix table B.3 and find qualitatively similar results. Inspecting

Table 2: Investor activity and expected excess returns (IV)

	Dependent variable:						
	inv_{nq}						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\widehat{rx}^{\pi}_{nq}$ (instrumented)	0.035***	0.043***	0.042***	0.031***	0.065***	0.068***	0.037**
	(0.008)	(0.011)	(0.011)	(0.009)	(0.015)	(0.016)	(0.011)
$avvol_n$	0.007*	0.008*	0.008*				−0.010
	(0.004)	(0.003)	(0.004)				(0.006)
$r^{f,\pi}_q$		0.010			0.054*		
		(0.021)			(0.021)		
Constant	−0.036	−0.062*					
	(0.028)	(0.031)					
First stage F-Stat	39.71	59.86	7.77	22.21	11.29	11.15	9.04
Neighborhood FE	No	No	No	Yes	Yes	Yes	No
Quarter FE	No	No	Yes	No	No	Yes	No
City×Quarter FE	No	No	No	No	No	No	Yes
Observations	41,007	41,007	41,007	41,007	41,007	41,007	41,007
Note:							*p<0.05; **p<0.01; ***p<0.001

Table shows regression results from regressing annual share of purchases by institutional investors onto instrumented expected excess returns using equation (4) on sample from 2006 to 2018.

$$inv_{nq} = \alpha_{(c,n,q)} + \beta \widehat{\overline{rx}}^{\pi}_{n,q} + \gamma X_{n,q} + \varepsilon_{n,q} \tag{5}$$

Standard errors clustered two-ways by city and calendar quarter.

All things equal, an increase in expected excess returns by 1 percentage point increases the

[7] Using institutional investor market share as dependent variable leads to qualitatively identical and statistically significant results.

likelihood of investor activity by around 4pp before controlling for fixed effects. The risk-free rate has no consistently significant effect on the activity of institutional investors but indirectly affects their decisions through its effect on expected excess returns in the first stage in table 1. There is a marginally significant relationship between institutional investor activity and volatility of housing returns that points toward more investor activity in neighborhoods with higher volatility.

In summary, this section has shown that expected excess returns on single family housing are primarily driven by household funding constraints and their variation across time and geographies. When lending standards are low and households have ample access to credit, expected excess returns are low. If lending standards increase, the funding constraints of exposed neighborhoods with high population shares of marginal borrowers tighten which leads to an increase in expected excess returns unrelated to volatility of housing returns. Declining risk-free rates amplify this mechanism. Institutional investors unaffected by funding constraints trade on this mechanism and entered into the market for single family housing in neighborhoods with high expected excess returns.

The following section inspects the measurable effects that their entry had on households and investors' *realized* returns on their investments.

4 The effects of institutional investor entry

Institutional investor activity is not evenly distributed across the U.S., but geographically concentrated. This implies that the potential impact of institutional investor activity, positive or negative, is disproportionately distributed not only geographically, but also demographically due to cross-sectional variation in neighborhood characteristics. Specifically, appendix figure A.2 shows that, *across* and *within* cities, neighborhoods that institutional investors entered are more diverse, younger and lower in income.

Moreover, institutional investor activity also has differential effects across households *within* neighborhoods, as their activity impacts markets for both home purchases and rentals. Intuitively, their entry shifts the demand curve for single family housing outward, leading to a relative increase in house prices that benefits incumbent home-owners and potentially crowds

out other prospective home-buyers. However, the potential effects on the rental market are ambiguous. If institutional investors merely replaced smaller incumbent landlords, then their activity would largely reflect within industry consolidation that itself could have positive or negative effects. If larger landlords can pass scale efficiencies on to consumers, then this would likely be a net gain to households. Instead, if consolidation leads to an increase in market power and rental markups the effects are a net negative.

I investigate the effects of investor entry on households in two parts. Firstly, by leveraging recent advances in the DiD literature I investigate the effects of institutional investor presence on housing affordability and find a strongly negative effect on the affordability of both buying and renting. Secondly, I place this finding into additional context by investigating the effect of investor entry on home-ownership rates and show that the equilibrium effect of institutional investor activity is a marginal displacement of homeowners.

Figure 4: Geographic distribution of institutional investors

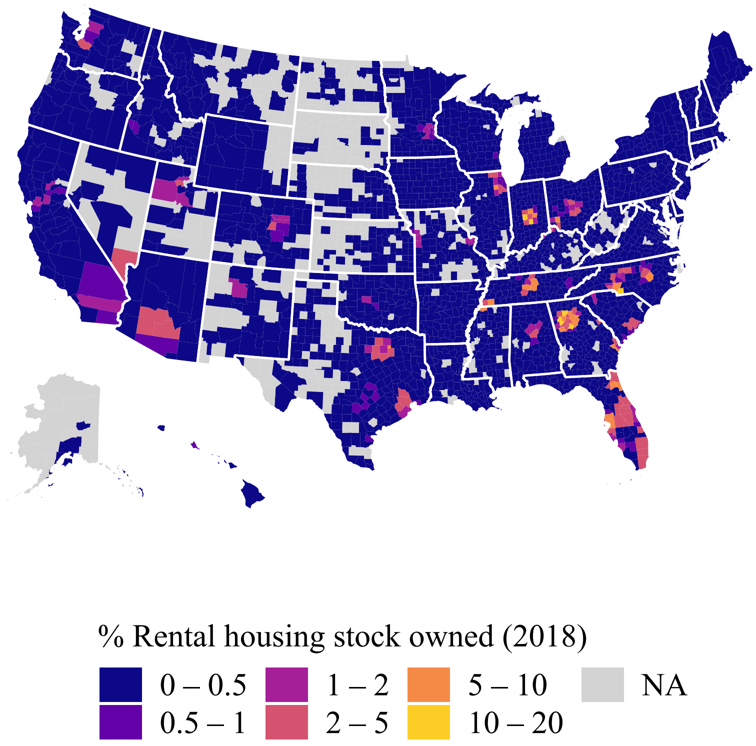


Figure shows geographic distribution of institutional investor landlords. Counties with an estimated housing stock of less than 1000 units of single family housing omitted and shaded in gray. Rental housing stock estimated as (1-home ownership rate (2018 ACS))×estimated housing stock for each county.

Housing affordability I investigate institutional investors' impact by tracing out the total effect of their activity on housing affordability over 3 years (12 quarters) following their entry into a neighborhood. Given that institutional investors enter neighborhoods neither randomly nor at the same time, it is necessary to think carefully about the correct specification of treatment and control groups, as well as the nature of the treatment.

Within the context of a differences-in-differences study I estimate the dynamic effects δ_ℓ of institutional investor entry $I_{n,q} \in \{0,1\}$ on housing affordability $Y_{n,q}$, where entry is defined as the first quarter F_n in which institutional investors own more than $\underline{\mu} = 0.25\%$ of the housing stock in neighborhood n.[8] While this likely implies that actual entry occurred in an earlier quarter and does not differentiate between neighborhoods with different intensities of institutional investor activity, it has the advantage that it fits my study into a staggered differences-in-differences design with binary treatment and potentially heterogeneous treatment effects, for which Callaway and Sant'Anna (2021) derive consistent estimators and helpfully provide an R-package. To address potential mis-measurement of entry timing I allow for anticipation effects up to 3 quarters prior. This changes the baseline period to which affected and unaffected neighborhoods are compared to that 3 quarters before F_n, the point at which I observe them owning more than 0.25% of the housing stock.

My main outcome variables of interest are neighborhood rent-to-income and price-to-income levels. Because entry decisions are not random, parallel trend assumptions are unlikely to hold unconditionally across neighborhoods. In order to control for different likelihoods of institutional investor activity across neighborhoods and potential differences in rental growth unrelated to institutional investor activity I include the estimated probability of institutional investor activity $\widehat{inv}_{n,q}$ backed out from my IV estimates in table 2 and forecasts of rental cash flow growth from the VAR used to estimate expected excess returns as control variables. This relaxes the parallel trends assumption from an unconditional assumption to an assumption conditional on the backed out probability of institutional investor activity $\widehat{inv}_{n,q}$ and expected rental growth.

Figure 5 illustrates the results from this exercise and illustrates that there are substantial effects on housing affordability *after* controlling for the likelihood of investor entry. Within three years

[8] Varying the threshold for entry trades off a higher risk of picking up false entry positives due to measurement error in the identification of institutional investors against higher measurement error in the actual timing of entry.

(12 quarters) of initial investor entry F_n the ratio of rent expenditures to adjusted gross income increases by 1.2 percentage points. The average rent-to-income ratio of neighborhoods that institutional investors entered is 0.22, which implies a relative increase in the ratio of rent to pre-tax adjusted gross income of over 5%. Price-to-income levels increase by 30 percentage points, which implies an average relative increase of house prices by around 7%.

Appendix figure A.3 shows similar findings for real log rents and real log house prices and insignificant effects on real log income. This confirms that these results are not driven by income changes across neighborhoods. Nevertheless, there is some (insignificant) suggestive evidence that income levels in neighborhoods that institutional investors enter relatively decline. This effect is sufficiently small that it is not the driver of declining housing affordability, but could point toward the existence of general equilibrium effects that I discuss further in section 5.

Figure 5: Effects of institutional investor presence on housing affordability

(a) Rent-to-income (b) Price-to-income

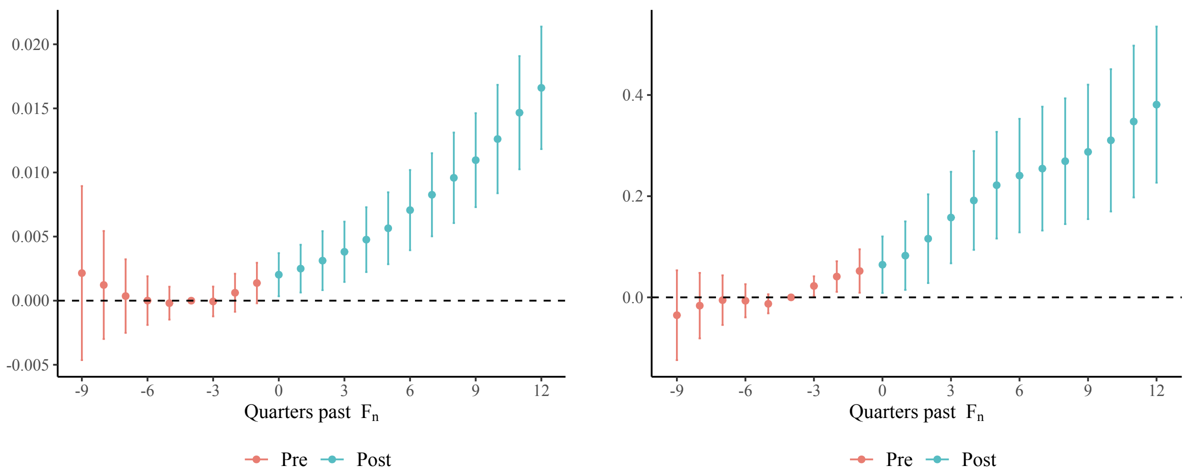


Figure shows DiD estimates of the effect of institutional investor entry $I_{n,q}$ on rent-to-income and price-to-income levels, controlling for likelihood of institutional investor activity $\widehat{inv}_{n,q}$ and expected rental growth $(1-\rho_n)\widehat{\mathbb{E}}\left[\sum_{j=0}^{\infty}\rho_n^j \Delta d^{\pi}_{n,q+j+1}\right]$ and allowing for anticipation effects 3 quarters prior. Standard errors clustered at the level of assignment (neighborhood).

While increases in house prices are natural responses to an outward shift in the demand curve, increases in rents are more difficult to rationalize and raise serious concerns about potential exertion of market power in the rental market which I leave as an interesting avenue for future research.

Home Ownership The broad decline in housing affordability suggests that these patterns could have an effect on home-ownership rates. To investigate this, I aggregate zip-code level housing stock owned by institutional investors up to the county level and compare changes in county level home-ownership rate estimates from the ACS with the estimated change in institutional investor owned housing stock constructed from the deeds records. Because ACS estimates of county home-ownership rates are based on the 5 year ACS survey I restrict my attention to the long difference in home-ownership rates to smooth out noise in the measurement of the dependent variable.

$$\Delta_{10}^{18} hown_{cty}^{ACS} = \alpha_{(c)} + \beta \Delta_{10}^{18} iown_{cty}^{deeds} + \varepsilon_{cty} \tag{6}$$

Since the housing market of most cities spans multiple counties, I run this regression both with and without city fixed-effects, which allows me to verify that these patterns are not driven by city-wide trends.

Table 3: Change in institutional owned housing stock and county home ownership rate

	Δ_{10}^{18} % County level home ownership rate	
Δ_{10}^{18} % of owned housing stock, Big 6	-1.381^{***}	-0.948^{***}
	(0.198)	(0.303)
Fixed effects	No	Market
Observations	488	488
R^2	0.247	0.583
Adjusted R^2	0.246	0.519
Note:		*p<0.1; **p<0.05; ***p<0.01

Table shows regression results from regressing percentage point changes in county level home-ownership rate onto estimated percentage point changes in county level institutional investor owned housing stock.

$$\Delta_{10}^{18} hown_{cty}^{ACS} = \alpha_{(c)} + \beta \Delta_{10}^{18} iown_{cty}^{deeds} + \varepsilon_{cty}$$

Standard errors clustered at city level.

There is a strong negative relationship between changes in county level home-ownership rates and the increase in housing stock owned by institutional investors that captures nearly a quarter of the variation in county level changes in how ownership rates. Interpreting the estimated coefficients at face value, for every percentage point of housing stock bought by institutional investors between 2010 and 2018 the home ownership rate decreased by 1.3 percentage points. As my measure is by construction an underestimate of investor activity, for example due to

omitting smaller investors, this is inherently plausible. This suggests that the equilibrium effect of institutional investor entry is a displacement of incumbent homeowners at the margin that turns them into renters. Including city level fixed effects leads to a slightly lower but strongly significant coefficient estimate of -0.948, which shows that my findings are not driven by city level trends.

Investment performance The previous findings should imply that institutional investors earned substantial *realized* excess returns on their investments, in line with their *expected* excess returns. I confirm this by measuring realized *excess* returns $rx^{\pi}_{n,q\to q+k}$ over the next k quarters from the time of purchase.[9] Additionally, I also compute annualized realized *net* returns $y^{\pi}_{n,q\to q+k}$, which I decompose into net rental yields $y^{d^{\pi}}_{n,q\to q+k}$ and appreciation returns $y^{p^{\pi}}_{n,q\to q+k}$.

$$
\begin{aligned}
y^{\pi}_{n,q\to q+k} &\equiv \frac{4}{k}\Bigg(\underbrace{\frac{\sum_{j=1}^{k} D^{\pi}_{n,q+j} - \tau(P_{n,q+j}, D_{n,q+j})}{P^{\pi}_{n,q}}}_{=y^{d^{\pi}}_{n,q\to q+k}} + \underbrace{\frac{P^{\pi}_{n,q+k} - P^{\pi}_{n,q}}{P^{\pi}_{n,q}}}_{=y^{p^{\pi}}_{n,q\to q+k}}\Bigg), \\
rx^{\pi}_{n,q\to q+k} &\equiv y^{\pi}_{n,q\to q+k} - r^{f,\pi}_{q\to q+k}
\end{aligned}
$$

Table 4 reports the results from regressing annualized excess returns over the next 3 years $rx^{\pi}_{n,q\to q+12}$ onto current institutional investor activity $inv_{n,q}$ and shows that on average, institutional investors realized excess returns of 13.14% p.a. in the three years following their purchases, significantly exceeding the unconditional average excess return of 5.87%.[10]

Roughly two thirds of this is driven by aggregate variation in excess returns over time, as revealed by the inclusion of quarter fixed effects, which shrink the coefficient on investor activity by over two thirds and absorb about 60% of total variation. Given that investors timed their entrance to a point in time when expected excess returns were high in the aggregate this is unsurprising. However, even within a given quarter realized excess returns in neighborhoods that saw institutional investor activity were 2.73% p.a. higher than neighborhoods that did not, which aligns with previous results showing that conditional on their timing decision institutional

[9]This exercise partially overlaps with the work of Demers and Eisfeldt (2022) who find similar results to the extent that our analysis coincides.

[10]These findings are robust to the choice of investment horizon.

Table 4: Institutional investor activity and excess returns

	Dependent variable: $rx^{\pi}_{n,q\to q+12}$ (in %, annualized)				
	(1)	(2)	(3)	(4)	(5)
inv_{nq}	7.927***	2.726***	8.377***	2.532***	0.926***
	(1.083)	(0.536)	(1.264)	(0.586)	(0.266)
Constant	5.217***				
	(0.930)				
Quarter FE	No	Yes	No	Yes	No
Neighborhood FE	No	No	Yes	Yes	No
City×Quarter FE	No	No	No	No	Yes
Observations	48,745	48,745	48,745	48,745	48,745
Adjusted R^2	0.036	0.640	0.076	0.690	0.921

Table shows regression results from regressing realized ex-post excess returns onto institutional investor activity dummy and fixed effects $\alpha_{(c,n,q)}$ *on full sample from 2000 to 2018.*

$$rx^{\pi}_{n,q\to q+12} = \alpha_{(c,n,q)} + \beta\ inv_{n,q} + \varepsilon_{n,q}$$

Standard errors two-way clustered by market and calendar quarter

investors seek out geographies with high expected excess returns in particular.

Including even more granular city×quarter fixed effects absorbs nearly 90% of the variation in realized excess returns, illustrating that the majority of neighborhood level returns are driven by wider trends across time and metro areas and not idiosyncratic to neighborhoods. Notwithstanding, the evidence shows that even *within* a given city and quarter neighborhoods in which institutional investors were active realized 0.93% p.a. higher excess returns than those that did not.

Appendix table B.3 regresses realized net returns $y^{\pi}_{n,q\to q+12}$ over the next 3 years onto current investor activity and their decomposition into real net rental yields $y^{d^{\pi}}_{n,q\to q+12}$ and real appreciation returns $y^{p^{\pi}}_{n,q\to q+12}$. This decomposition exercise reveals that appreciation gains account for the majority of investor's realized returns. Interestingly, the decomposition and inclusion of time and neighborhood fixed effects reveals that appreciation gains and net rental yields are driven by very different forces. While including quarter fixed effects captures nearly 60% of the variation in appreciation gains, they capture less than 15% of variation in net rental yields. Conversely, neighborhood fixed effects absorb over 75% of variation in net rental yields while they absorb less than 10% of variation in appreciation gains. I interpret these findings as evidence that appreciation gains are strongly correlated *across* cities and neighborhoods *within* quarters but vary substantially over time, while net rental yields are comparatively stable over

time *within* neighborhoods but vary substantially *across* neighborhoods. This is particularly evident when looking at the inclusion of city×quarter fixed effects - while they absorb over 90% of variation in appreciation gains, they only absorb 39% of the variation in net rental yields.

Interpreting table B.3 further, net rental yields contribute substantially more to the *conditional* realized excess returns after controlling for the timing decision of investor entry. Specifically, net rental yields contribute around 1/3 of the 2.7% p. a. higher returns that institutional investors earned within a given quarter and nearly 2/3 of the 0.92% p. a. higher returns that institutional investors earned within a given quarter and city. Put differently, appreciation gains broadly depend on the timing of *when* to enter into the housing market, while rental yields hinge upon the choice of *where* to buy. Institutional investors successfully factored in both of these factors to earn substantial returns.

5 Discussion

In summary, the previous sections show that the entry of institutional investors into the single family market is an equilibrium response to an increase in expected excess returns on single family housing driven by a tightening of household funding constraints.

Who benefits? Concerning the distributional implications of this development, the model and data point toward ambiguous effects distributed unevenly between both households *within* a neighborhood and *across* neighborhoods.

Within a neighborhood, incumbent home-owners clearly benefit from housing demand that is suppressed by funding constraints shifting outward and house prices appreciating. However, there are also obvious drawbacks for incumbent renters and marginally displaced prospective home-owners. Not only because this makes house purchases relatively less affordable, but also because the data suggests that affordability in the rental market also declines, which reaffirms concerns raised by policymakers and in recent media coverage.

Additionally, there are likely general equilibrium effects *across* neighborhoods. As shown by Levy (2022), the vast majority of landlords live locally, which means that their rental income will (partially) re-enter into the local economy through their consumption expenditures. In contrast,

renting from outside investors represents a transfer of rental income away from the local economy into the economies of the outside investors' shareholders. This amplifies regional inequality and possibly lowers aggregate income in the affected geographies, as suggested by panel (c) of figure A.3. Specifically, in light of the geographic distribution of institutional investor activity and wealth, this presents a transfer from the relatively less wealthy Central U.S. toward the East and West coasts, from which institutional investor landlords are conspicuously absent.

This insight relates my work to a broader literature on the distributional impact of low interest rate environments and illustrates that interest rates not only shape aggregate wealth inequality, but also regional inequality.

Effect of the risk-free rate & rational expectations On the subject of the risk-free rate, it is worth noting that the effect of a decline in the risk-free rate on prices and expected excess returns in my stylized model presented in section 2 is small compared to the effects estimated in section 3. The reason for this lies in the stylized nature of the model and the assumptions necessary to derive closed form solutions. While the model qualitatively captures the forces at work, the assumption that expected future prices are independent of future state variables, such as the risk-free rate, leads to an understatement of their effects. If current prices are a function of state variables then rational expectations of future prices should incorporate these as well. However, due to the non-linearity of prices caused by state-dependent investor participation in each period, deriving a closed form solution that solves for the rational expectations equilibrium is infeasible.

Nevertheless, thinking about the rational expectations equilibrium does reveal further insights: Firstly, under rational expectations prices are a function of the expected paths of future rents, household funding constraints and risk-free rates. Secondly, a rational investor will price in the ability to re-sell properties to households at a profit if household funding constraints slacken in the future.[11] Thirdly, the fact that prices depend on the expected path of future rents and risk-free rates illustrates that another channel through which risk-free rates amplify household

[11] Indeed, one firm outside the scope of analysis in this paper already operates on this premise and has turned it into a business model. The firm offers households a lease purchase program in which the firm purchases single family homes on behalf of households and rents the property to the household with an option to purchase the property from the firm at any point within 5 years. Intuitively, the firm would only offer this contract if it expects the household to pay at least the present value of the stream of rental cash flows that the property presents to the investor.

funding constraints is the duration mismatch between household portfolios and housing. In recent work Greenwald et al. (2022) document that households in the bottom group of the wealth and income distribution hold much lower duration portfolios, with most of their savings held largely in short-term deposits. This amplifies the effect that a decline in interest rates has on household funding constraints, as the value of household deposits does not adjust in response to a decline in interest rates while the value of a high duration assets such as housing increases disproportionately. As such, this is a further channel outside the scope of my model that leads to an understatement of the effect of declining interest rates.

Alternate channels Mills et al. (2019) suggest that the emergence of technology that facilitates landlord operations could be responsible for the entry of institutional investors into the single family rental market. Indeed, all things equal a reduction in maintenance costs clearly increases (expected) excess returns. However, it is very unlikely that this factor is the underlying cause. To illustrate, I consider a permanent one-time reduction of insurance and repair costs by 33% in 2011Q1 and plot the implied time-series of net expected excess returns on single family rentals against their baseline estimates in figure A.4. While a reduction in operating costs increases expected excess returns, the magnitude of this effect is small, making it unlikely that this is the underlying cause of institutional investor entry. However, technological improvements or potential scale economies that lower operating costs can potentially rationalize institutional investor's continued activity as expected excess returns decrease towards the end of my sample period. As such, a more realistic cost structure for the institutional investor outside the scope of this paper would likely include convex transaction costs and concave maintenance costs.

Another proposed channel is an oversupply of housing and foreclosures. Inspecting the data, panel (a) of figure A.5 shows that expected excess returns rise as foreclosures pick up in the aftermath of the housing bust. To the extent that foreclosures are reflective of tightened household funding constraints that force households to liquidate part of their position in housing, I view foreclosures as part of my mechanism reminiscent of the mechanism described by Shleifer and Vishny (1992).[12] However, panel (b) of figure A.5 shows that even at the peak of foreclosure activity only a fraction of the properties bought by institutional investors had gone through a

[12] It is worth emphasizing that in this context oversupply is due to suppression of household demand that shifts demand inward, as opposed to being due to an outward shift in supply.

foreclosure in the 3 years leading up to their purchase. In later years as the supply of foreclosures dries up there are even fewer purchases of homes that went through a foreclosure process. As such, I view evidence of foreclosures leading to investor entry as complementary to my work.

Looking forward This paper has shed light on the causes and implications of institutional investor entry into the single family rental market. Perhaps the most interesting question is how this will develop further. During the Covid pandemic we were able to observe these actors expand their operations, which suggests that this continues to be an ongoing phenomenon.

One of the key takeaways from imposing rational expectations is that looser household funding constraints could lead to investors reselling properties to the household sector in the future. This decisions likely hinges upon the extent of possible rental markups and scale economies that investors can capitalize on relative to the premium that households are willing to pay for home-ownership. Markups and scale economies will depend on the level of competition within the industry. The fewer and larger firms are, the more pronounced these effects will be, giving room for strategic behavior of firms within the rental sector and making it more likely for them to remain in the market.

In particular, it implies that the expected excess returns of an incumbent institutional investor could differ from the expected excess returns of a new entrant. In the data and industry reports there is a distinct lack of followers into this market. Moreover, according to industry reports there has been substantial consolidation within the industry. Both of these observations point toward room for future work on the strategic behavior of firms in this space.

Lastly, it is worth speculating how institutional investors will respond to a new environment of rising inflation and nominal interest rates. As long as real rates remain low, as is currently the case, the opportunity costs of institutional investors remain low. However, household funding constraints frequently not only impose down-payment requirements, as assumed in section 2, but also impose limits on the ratio of interest payments to income. If mortgage rates increase in line with nominal interest rates this can also tighten household funding constraints and induce investors to enter new markets or intensify their presence in existing ones.

6 Concluding remarks

To conclude, this paper documents and quantifies the emergence of institutional investor landlords. I use an instrumental variables approach to show that their activity is an equilibrium response to an increase in expected excess returns driven by tightening household funding constraints. The neighborhoods they entered skew more diverse, poorer and younger. Following their entry house prices and rents increased, leading to an overall decline in housing affordability and home-ownership rates. While their entry has a stabilizing effect on prices, benefiting incumbent home-owners, it harms prospective home-owners and renters.

Additionally, as highlighted in the discussion section there are a number of promising avenues for further research on the topic, especially with regards to the strategic behavior of firms in this space and potential general equilibrium effects.

References

Adelino, Manuel, Antoinette Schoar, and Felipe Severino, "Dynamics of Housing Debt in the Recent Boom and Great Recession," NBER Working Papers 23502, National Bureau of Economic Research, Inc 2017.

Black, Fischer, "Capital Market Equilibrium with Restricted Borrowing," *The Journal of Business*, 1972, *45* (3), 444–55.

Buchak, Greg, Gregor Matvos, Tomasz Piskorski, and Amit Seru, "Why is Intermediating Houses so Difficult? Evidence from iBuyers," Working Paper 28252, National Bureau of Economic Research December 2020.

Callaway, Brantly and Pedro H.C. Sant'Anna, "Difference-in-Differences with multiple time periods," *Journal of Econometrics*, 2021, *225* (2), 200–230. Themed Issue: Treatment Effect 1.

Campbell, John Y and Robert J Shiller, "The dividend-price ratio and expectations of future dividends and discount factors," *The Review of Financial Studies*, 1988, *1* (3), 195–228.

Campbell, Sean D., Morris Davis, Joshua Gallin, and Robert F. Martin, "What moves housing markets: A variance decomposition of the rent-price ratio," *Journal of Urban Economics*, 2009, *66* (2), 90–102.

Demers, Andrew and Andrea L. Eisfeldt, "Total returns to single-family rentals," *Real Estate Economics*, 2022, *50* (1), 7–32.

D'Acunto, Francesco and Alberto G Rossi, "Regressive Mortgage Credit Redistribution in the Post-Crisis Era," *The Review of Financial Studies*, 02 2021. hhab008.

Favilukis, Jack and Stijn Van Nieuwerburgh, "Out-of-Town Home Buyers and City Welfare," *The Journal of Finance*, 2021, *76* (5), 2577–2638.

Frazzini, Andrea and Lasse Heje Pedersen, "Betting against beta," *Journal of Financial Economics*, 2014, *111* (1), 1–25.

Greenwald, Daniel and Adam Guren, "Do Credit Conditions Move House Prices?," Working Paper 2020.

_ , **Matteo Leombroni, Hanno N. Lustig, and Stijn Van Nieuwerburgh**, "Financial and Total Wealth Inequality with Declining Interest Rates," Technical Report July 2022.

Hartman-Glaser, Barney and William Mann, "Collateral constraints, wealth effects, and volatility: evidence from real estate markets," Working Paper 2021.

Kaplan, Greg, Kurt Mitman, and Giovanni L. Violante, "The Housing Boom and Bust: Model Meets Evidence," *Journal of Political Economy*, 2020, *128* (9), 3285–3345.

Levy, Antoine, "Housing Policy with Home-Biased Landlords: Evidence from French Rental Markets," Working Paper 2022.

Lo, Andrew W., "The Statistics of Sharpe Ratios," *Financial Analysts Journal*, 2002, *58* (4), 36–52.

Mian, Atif and Amir Sufi, "House Prices, Home Equity-Based Borrowing, and the US Household Leverage Crisis," *American Economic Review*, August 2011, *101* (5), 2132–56.

_ **and** _ , "Credit Supply and Housing Speculation," *The Review of Financial Studies*, 03 2021.

Mills, James, Raven Molloy, and Rebecca Zarutskie, "Large-Scale Buy-to-Rent Investors in the Single-Family Housing Market: The Emergence of a New Asset Class," *Real Estate Economics*, 2019, *47* (2), 399–430.

Piazzesi, Monika and Martin Schneider, "Housing and Macroeconomics," Working Paper 22354, National Bureau of Economic Research June 2016.

Shleifer, Andrei and Robert W. Vishny, "Liquidation Values and Debt Capacity: A Market Equilibrium Approach," *Journal of Finance*, 1992, *47* (4), 1343–1366. Reprinted in Michael J. Brennan, ed., The Theory of Corporate Finance, Edward Elgar Publishing Company, 1996.

A Appendix: Additional figures

Figure A.1: Tightening of lending standards

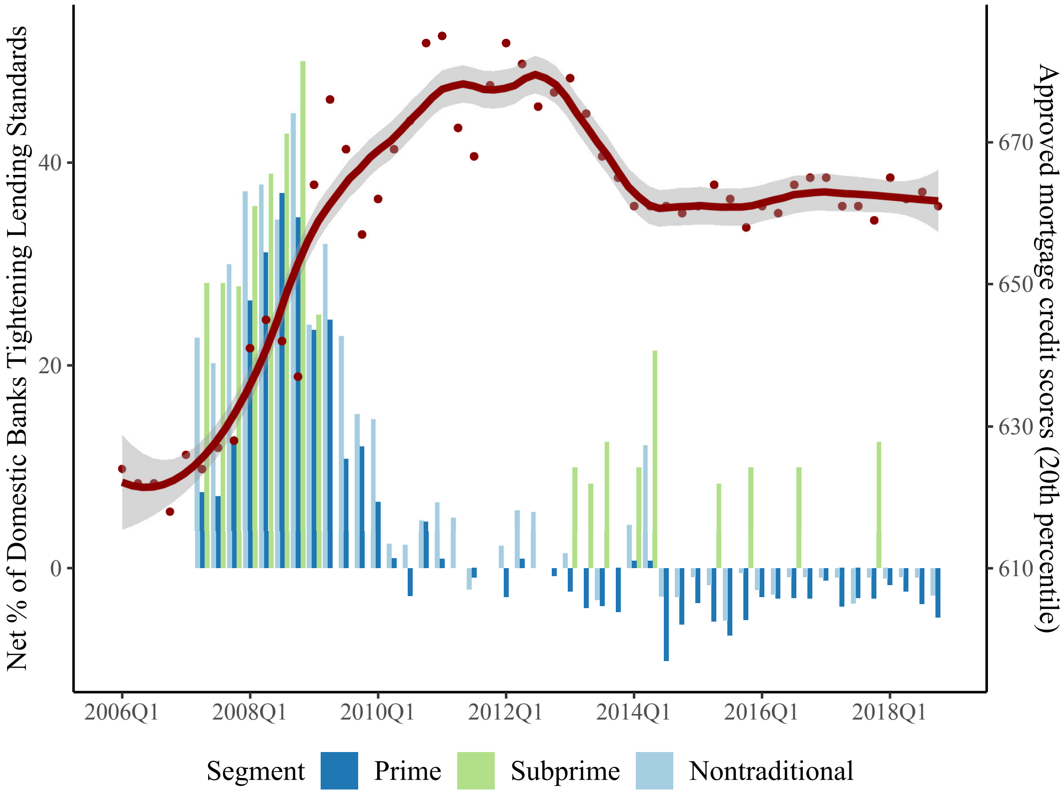


Figure shows net % of domestic banks reporting a tightening of lending standards measured by the Federal Reserve Survey of Senior Loan Officers in bar chart on left axis, starting in 2007. Right axis plots quarterly 20th percentile of approved mortgage applicants' credit scores, starting in 2006, both smoothed and in raw data points. Banks reporting tightening of subprime lending standards only reported in quarters where more than 3 banks report making subprime loans.

Figure A.2: Demographics of institutional investor neighborhoods

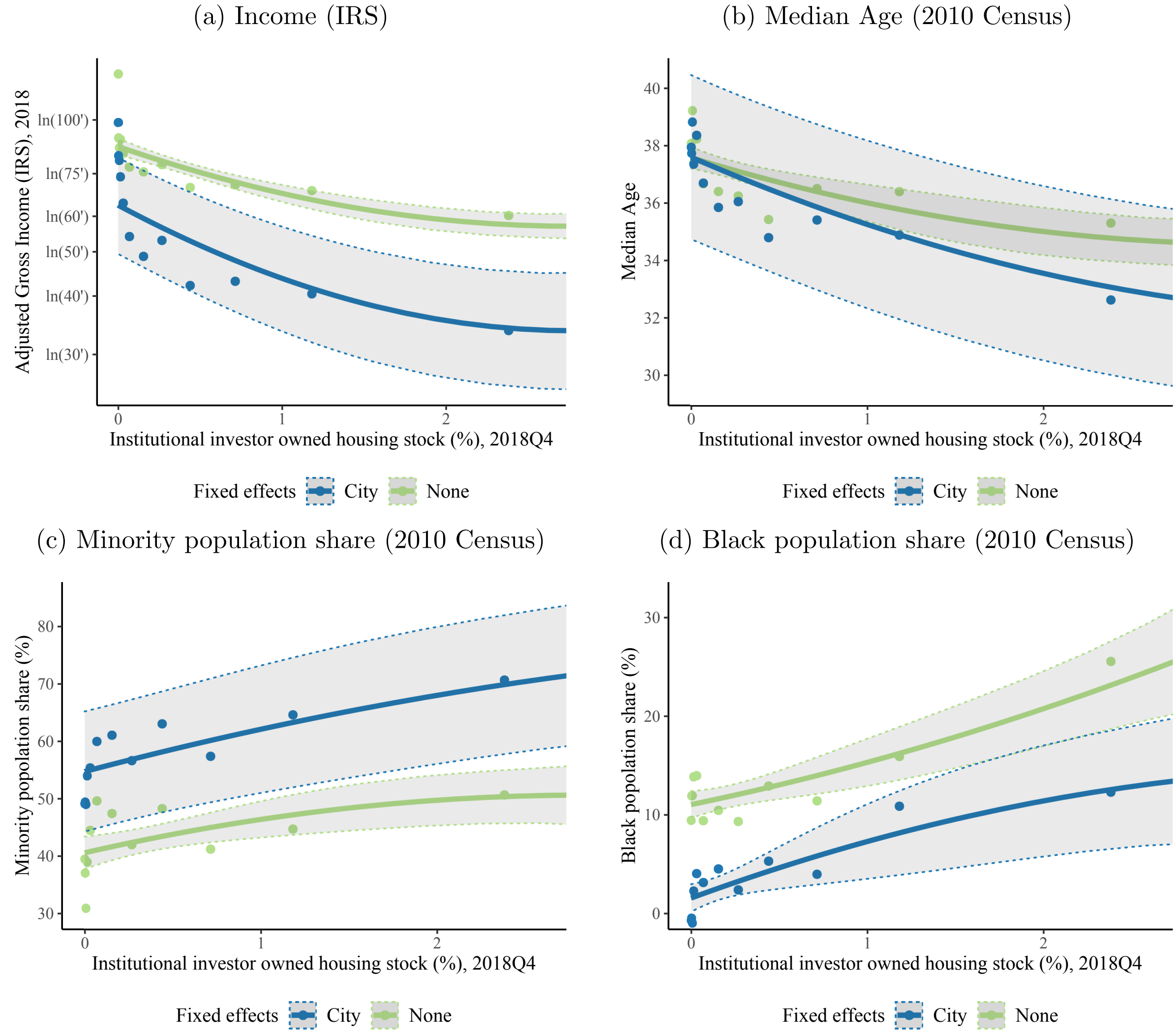


Figure shows bin scatter plots of neighborhood demographic characteristics y_n from 2010 Census and 2018 IRS plotted against share of institutional investor owned housing stock in 2018Q4, the final quarter of my sample period with and without city level fixed effects.

$$y_n = \alpha_{(c)} + \beta \ inv^{own}_{2018Q4} + \varepsilon$$

Solid lines represents quadratic polynomial fitted to the binned scatter plot and its 95% confidence band. Green indicates figures estimated without fixed effects, blue indicates figures estimated including city level fixed effects.

Figure A.3: Effects of institutional investor presence

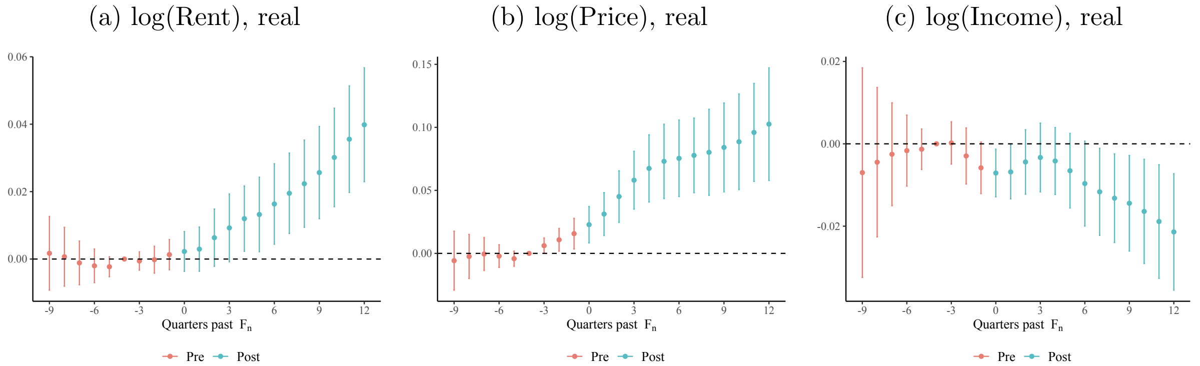


Figure shows results from a differences-in-differences regression studies the effect of institutional investor entry $I_{n,q}$ *on rent-to-income and price-to-income levels, controlling for likelihood of institutional investor activity* $\widehat{inv}_{n,q}$ *and expected rental growth* $(1-\rho_n)\widehat{\mathbb{E}}\left[\sum_{j=0}^{\infty}\rho_n^j \Delta d^{\pi}_{n,q+j+1}\right]$.

$$Y_{n,q} = \alpha_n + \alpha_q + \sum_{\ell=K}^{-2} \delta_\ell^{placebo} \cdot I^\ell_{n,q} + \sum_{\ell=0}^{L} \delta_\ell \cdot I^\ell_{n,q} + \beta X_{n,q} + u_{,nq}$$

Standard errors clustered at the level of assignment, neighborhood level

Figure A.4: Expected excess returns under different levels of operating costs

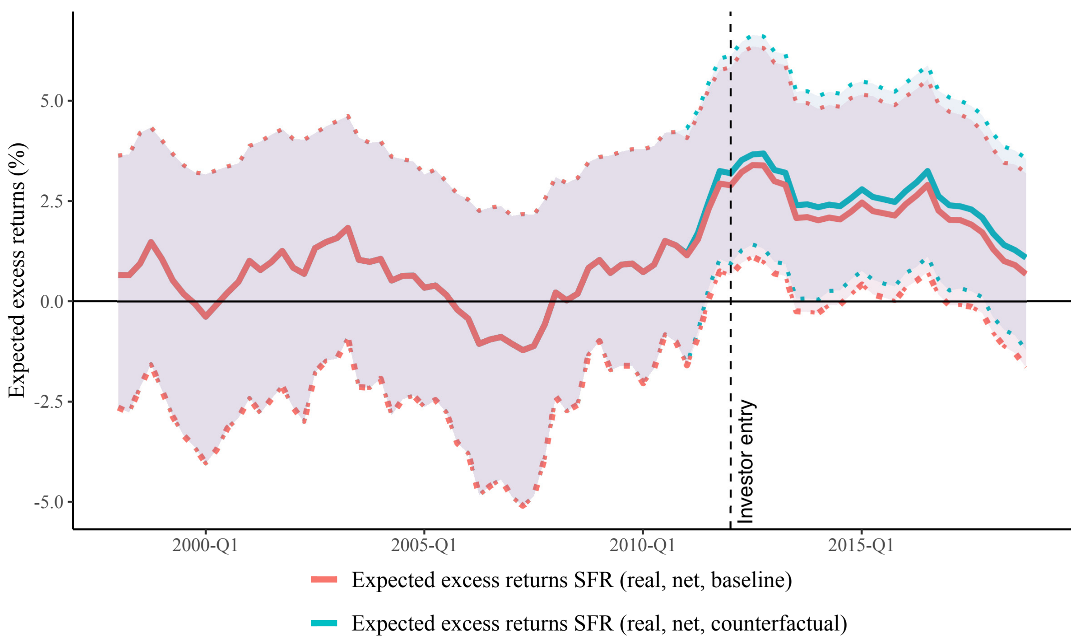
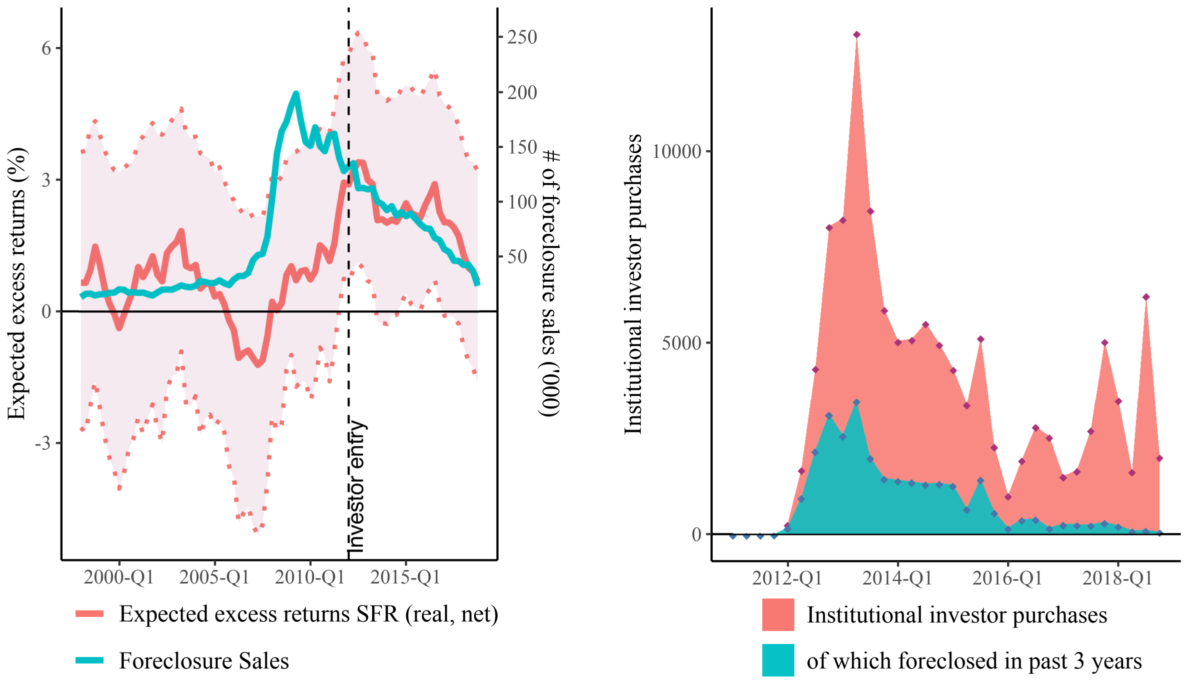


Figure plots expected excess returns under baseline regime of operating costs drawn from Demers and Eisfeldt (2022) and counterfactual scenario of 33% lower operating costs.

Figure A.5: Institutional investor activity and foreclosure activity

(a) Foreclosures and expected excess returns

(b) Foreclosure purchases



Panel (a) plots time series of estimated (net) expected excess returns on single family housing on left axis and number of transactions marked as foreclosure sales in CoreLogic deeds records on right axis. Panel (b) plots total number of properties bought by institutional investors and number of properties bought that were involved in a foreclosure process[a] *in the previous 3 years.*

[a] transaction marked as foreclosure or foreclosure sale in CoreLogic deeds

B Appendix: Additional tables

Table B.1: Explaining rent-price ratio on single family housing

	Dependent variable:						
	$D/P_{n,q}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$cred_q^{20}$(standardized)	-0.203^{*}	-0.400^{**}		-0.196	-0.408^{**}		
	(0.093)	(0.123)		(0.104)	(0.124)		
pop_{n06q1}^{exp}	0.134^{***}	0.134^{***}	0.138^{***}				0.134^{***}
	(0.018)	(0.018)	(0.018)				(0.023)
$cred_q^{20} \times pop_{n06q1}^{exp}$	0.019^{***}	0.019^{***}	0.019^{***}	0.018^{***}	0.018^{***}	0.019^{***}	0.026^{***}
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.002)
$r_q^{f,\pi}$		-0.341^{**}			-0.367^{**}		
		(0.124)			(0.111)		
$avvol_n$	-0.106^{**}	-0.106^{**}	-0.105^{**}				0.248^{**}
	(0.035)	(0.035)	(0.035)				(0.087)
$\log(\text{Inc}_{n,q}^{\pi})$	-1.073^{***}	-1.077^{***}	-0.973^{***}	-3.190^{***}	-3.284^{***}	-1.403^{**}	-0.140
	(0.231)	(0.231)	(0.233)	(0.532)	(0.467)	(0.415)	(0.238)
Constant	14.459^{***}	14.821^{***}					
	(3.011)	(3.021)					
Observations	41,070	41,070	41,070	41,070	41,070	41,070	41,070
Adjusted R^2	0.442	0.444	0.460	0.917	0.920	0.932	0.707
Within R^2	0.442	0.444	0.433	0.338	0.359	0.084	0.506
Neighborhood FE	No	No	No	Yes	Yes	Yes	No
Quarter FE	No	No	Yes	No	No	Yes	No
City×Quarter FE	No	No	No	No	No	No	Yes
Note:							*p<0.05; **p<0.01; ***p<0.001

Table shows regression results from regressing quarterly gross rent-price ratio (in pp) onto marginal borrower population share interacted with time series of 20th percentile of mortgage applicants credit scores using the full sample from 2006 to 2018.

$$D/P_{nq} = \alpha_{(c,n,q)} + \beta_1\ cred_q^{20} + \beta_2\ pop_{n,06q1}^{exp} + \beta_3\ cred_q^{20} \times pop_{n,06q1}^{exp} + \gamma X_{n,q} + \varepsilon_{n,q}$$

Standard errors two-way clustered by city and calendar quarter.

Table B.2: Investor activity and expected excess returns (OLS)

	Dependent variable:						
	inv_{nq}						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\widehat{rx}^{\pi}_{nq}$	0.015***	0.008**	0.009**	0.038***	0.036***	0.033***	0.004
	(0.004)	(0.003)	(0.003)	(0.008)	(0.007)	(0.007)	(0.002)
$avvol_n$	0.006	0.006	0.006				0.004
	(0.003)	(0.003)	(0.003)				(0.003)
$r^{f,\pi}_q$		−0.061***			−0.004		
		(0.016)			(0.010)		
Observations	41,007	41,007	41,007	41,007	41,007	41,007	41,007
R^2	0.029	0.046	0.144	0.237	0.237	0.318	0.531
Adjusted R^2	0.029	0.046	0.143	0.222	0.222	0.303	0.491
Quarter FE	No	No	Yes	No	Yes	No	
Neighborhood FE	No	No	No	Yes	Yes	Yes	No
City×Quarter FE	No	No	No	No	No	No	Yes
Note:					*p<0.05; **p<0.01; ***p<0.001		

Table shows regression results from regressing quarterly indicator of purchase activity by institutional investors onto expected excess returns on sample from 2006 to 2018.

$$inv_{nq} = \alpha_{(c,n,q)} + \beta \widehat{rx}^{\pi}_{n,q} + \gamma X_{n,q} + \varepsilon_{n,q}$$

Standard errors clustered two-ways by city and calendar quarter.

Table B.3: Investor activity and expected excess returns (D/P-IV)

	Dependent variable:						
	inv_{nq}						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D/P_{nq} (instrumented)	0.032***	0.027***	0.029***	0.067*	0.004	0.132***	0.030***
	(0.008)	(0.007)	(0.007)	(0.028)	(0.030)	(0.037)	(0.008)
$avvol_n$	0.007*	0.006*	0.006*				−0.014*
	(0.003)	(0.003)	(0.003)				(0.006)
$r^{f,\pi}_q$		−0.062***			−0.075**		
		(0.017)			(0.023)		
Constant	−0.156***	−0.072*					
	(0.037)	(0.031)					
First stage F-Stat	82.87	72.42	4.84	10.58	12.3	8.59	15.05
Neighborhood FE	No	No	No	Yes	Yes	Yes	No
Quarter FE	No	No	Yes	No	No	Yes	No
City×Quarter FE	No	No	No	No	No	No	Yes
Observations	41,070	41,070	41,070	41,070	41,070	41,070	41,070
Note:					*p<0.05; **p<0.01; ***p<0.001		

Table shows regression results from regressing annual share of purchases by institutional investors onto instrumented rent-price ratio in sample from 2006 to 2018.

$$inv_{nq} = \alpha_{(c,n,q)} + \beta D/P_{n,q} + \gamma X_{n,q} + \varepsilon_{n,q}$$

Standard errors clustered two-ways by city and calendar quarter.

Table B.4: Institutional investor activity and SFH returns

	Dependent variable:				
	$y^{\pi}_{n,q\rightarrow q+12}$ (in %, annualized)				
	(1)	(2)	(3)	(4)	(5)
inv_{nq}	6.724***	2.726***	7.042***	2.532***	0.926***
	(0.982)	(0.536)	(1.155)	(0.586)	(0.266)
Constant	5.433***				
	(0.843)				
Quarter FE	No	Yes	No	Yes	No
Neighborhood FE	No	No	Yes	Yes	No
City×Quarter FE	No	No	No	No	Yes
Observations	48,745	48,745	48,745	48,745	48,745
Adjusted R^2	0.029	0.592	0.076	0.648	0.910
Note:			*p<0.05; **p<0.01; ***p<0.001		

	Dependent variable:				
	$y^{p^{\pi}}_{n,q\rightarrow q+12}$ (in %, annualized)				
	(1)	(2)	(3)	(4)	(5)
inv_{nq}	5.828***	1.858***	6.611***	2.222***	0.353
	(0.911)	(0.518)	(1.046)	(0.547)	(0.189)
Constant	1.371				
	(0.792)				
Quarter FE	No	Yes	No	Yes	No
Neighborhood FE	No	No	Yes	Yes	No
City×Quarter FE	No	No	No	No	Yes
Observations	48,745	48,745	48,745	48,745	48,745
Adjusted R^2	0.026	0.582	0.071	0.630	0.941
Note:			*p<0.05; **p<0.01; ***p<0.001		

	Dependent variable:				
	$y^{d^{\pi}}_{n,q\rightarrow q+12}$ (in %, annualized)				
	(1)	(2)	(3)	(4)	(5)
inv_{nq}	0.894***	0.866***	0.428**	0.308***	0.568***
	(0.175)	(0.184)	(0.146)	(0.072)	(0.146)
Constant	4.060***				
	(0.187)				
Quarter FE	No	Yes	No	Yes	No
Neighborhood FE	No	No	Yes	Yes	No
City×Quarter FE	No	No	No	No	Yes
Observations	49,422	49,422	49,422	49,422	49,422
Adjusted R^2	0.009	0.131	0.771	0.910	0.444
Note:			*p<0.05; **p<0.01; ***p<0.001		

C Appendix: Data

C.1 Summary statistics

C.2 Identifying institutional investors

I identify activity of the institutional investors by matching buyer/seller names in CoreLogic deeds data onto regex expressions containing a list of subsidiaries found in SEC filings. Figure C.1 illustrates what an excerpt of these looks like in the case of Invitation Homes. Table C.1 lists the institutional investors that I focus on.

Table C.1: Largest institutional investors leasing single family housing, 2018

	Firm	Properties	Shareholders
1	American Homes 4 Rent	72,473	Vanguard, Blackrock, JPM Chase
2	Invitation Homes	65,819	Blackstone, Vanguard, Cohen and Steers
3	Pretium Capital	35,889	Private equity
4	Colony Starwood Homes	29,670	Vanguard, Cohen and Steers
5	Cerberus Capital	22,513	Private equity
6	Altisource/Frontyard Residential	15,888	Vanguard, Putnam, BlackRock

C.3 Construction of datasets

The main goal of my work in the deeds data is to measure purchase activity of institutional investors as well as their ownership of the housing stock over time and across geographies.

Measuring purchase activity is straightforward. I aggregate arms-length transactions by zipcode and quarter and count the number of transactions that involve institutional investors listed in C.1 as purchaser. This allows me to back out both the number of properties bought by institutional investors and their market share of purchases within neighborhoods in each quarter. For the purpose of exercise A.4 I also inspect whether the property transacted was involved in a foreclosure or foreclosure sale within 3 years prior to the transaction using an identifier provided by CoreLogic.

Measuring ownership involves slightly more work as it requires tracking ownership of the housing stock as well as the size of the total housing stock over time. Firstly, in order to track changes

in the housing stock I classify transactions into sales of existing properties and new builds.[13] This allows me to infer whether the transaction is merely a change in ownership of an existing home or adding a new home to the housing stock. The existing housing stock in a zipcode and quarter are all the properties that are not marked as a new construction sale in a future quarter. I back out ownership from the names of the buyer and seller recorded in the deeds data. For the first recorded transaction of an existing property I infer that the name of the owner in prior quarters is that of the seller. For all subsequent quarters the name of the owner is the name of the last recorded buyer (whether arms-length or not). I then match owner names onto my list of subsidiaries of institutional investors.

This allows me to construct zipcode-quarter panels of institutional investor owned housing stock in addition to the panel of transactions.

Figure C.1: SEC filings, extract, Invitation homes

(a) Invitation Homes subsidiaries from SEC filings, extract

Exhibit 21.1

Subsidiaries of the Registrant
Effective 12/31/2019

Name	**State of Formation**
2013-1 IH Borrower G.P. LLC	Delaware
2013-1 IH Borrower L.P.	Delaware
2013-1 IH Equity Owner G.P. LLC	Delaware
2013-1 IH Equity Owner L.P.	Delaware
2013-1 IH Property Holdco L.P.	Delaware
2015-3 IH2 Borrower TRS LLC	Delaware
2015-3 IH2 Property Holdco L.P.	Delaware
2015-3 IH2 Equity Owner G.P. LLC	Delaware
2015-3 IH2 Equity Owner L.P.	Delaware
2015-3 IH2 Borrower G.P. LLC	Delaware
2017-1 IH Property Holdco L.P.	Delaware
2017-1 IH Equity Owner G.P. LLC	Delaware
2017-1 IH Equity Owner L.P.	Delaware
2017-1 IH Borrower GP LLC	Delaware

D Appendix: Variable construction

[13] While CoreLogic provides an identifier on new construction sales, a cursory investigation of a random sample of transactions shows that this identifier misses a sizable number of transactions that are with high likelihood new construction sales, as they involve known nationally active home builders on the seller side. To address this issue, I augment the identifier provided with a list of regular expressions of known nationally active home builders and train a Natural Language Processing algorithm to identify home builders on the seller side.

D.1 Expected Excess Returns

I estimate a VAR of order l on $Z_{n,q} = \left[dp_{n,q}, \Delta d^{\pi}_{n,q}, rx_{n,q}\right]$ for each local housing market as in Campbell et al. (2009) and include MSA level labor force growth and changes in unemployment rates as well as the real risk-free rate and real GDP growth as additional exogenous variables $X_{n,q} = \left[\Delta e_{n,q}, \Delta u_{n,q}, r^{f,\pi}_{US,q}, \Delta y_{US,q}\right]$. The number of lags $l \leq 4$ is selected based on final prediction error[14].

$$Z_{n,q} = \sum_{l=1}^{L} A_{n,\ell} Z_{n,q-l} + \alpha X_{n,q} + \varepsilon_{n,q} \tag{7}$$

Coefficient estimates of $\{\hat{A}_{n,l}\}, \hat{\alpha}$ allow me to forecast expected excess returns $\widehat{rx}_{n,q+k}$ for each neighborhood n and quarter q given observations $Z_{n,q-\ell}$ and forecasts $\mathbb{E}_q\left[X_{n,q+k}\right]$. I estimate forecasts $\mathbb{E}_q\left[X_{n,q+k}\right]$ by partitioning $X_{n,q} = \left(X^1_{n,q}, X^2_{US,q}\right)$ and estimating an auxiliary VAR on $X^1_{n,q} = (\Delta e_{n,q}, \Delta u_{n,q})$

$$X^1_{n,q} = \sum_{\ell=1}^{L} B_{n,\ell} X^1_{n,q-\ell} + \beta X^2_{n,q} + \varepsilon_{n,q} \tag{8}$$

I estimate forecasts $\mathbb{E}_q\left[\widehat{X}^1_{n,q+k}\right]$ from the estimated coefficients $\{\hat{B}_{n,\ell}\}, \hat{\beta}$, observations of $X^1_{n,q}$ and forecasts $\mathbb{E}_q\left[X^2_{n,q+k}\right] = \left(\mathbb{E}_q\left[r^{f,\pi}_{US,q+k}\right], \mathbb{E}_q\left[\Delta y_{US,q+k}\right]\right)$ backed out from real long-term interest rate data released by the U.S. Treasury and short-term forecasts from the Survey of Professional Forecasters. I then plug in the combined forecasts $\left(\mathbb{E}_q\left[\widehat{X}^1_{n,q+k}\right], \mathbb{E}_q\left[X^2_{US,q+k}\right]\right)$ into equation (3) as exogenous variables to estimate forecasts $\mathbb{E}_q\left[\widehat{Z}_{n,q+k}\right]$ that allow me to back out $\widehat{rx}^{\pi}_{n,q}$.

D.2 Return volatility

Housing returns are highly auto-correlated and exposed to substantial idiosyncratic risk. As such, treating the time series of quarterly net excess returns $rx^{\pi}_{n,q}$ as draws from an i.i.d. distribution would understate their true volatility. I correct for auto-correlation by computing annualized volatility measures following Lo (2002). For each neighborhood I estimate the aver-

[14] Using alternative selection criteria such as BIC, AIC or MSE does not materially affect my results

age quarterly volatility of net excess returns in the data.

$$avvol_n^q = \sqrt{\frac{1}{K}\sum_{q=1}^{K}\left(rx_{n,q}^{\pi} - \overline{rx_n^{\pi}}\right)^2}$$

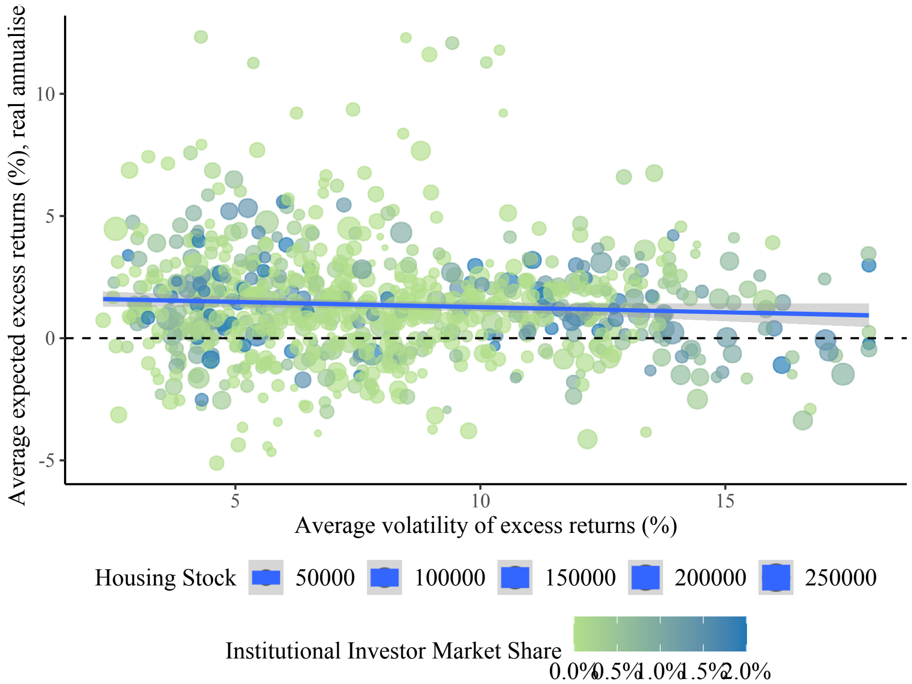
I then estimate an AR(1) process on quarterly excess returns and aggregate the volatility of quarterly returns to an annualized volatility measure correcting for auto-correlation.

$$avvol_n^a = \sqrt{4} \times \sqrt{1 + \frac{2\rho}{1-\rho}\left(1 - \frac{1-\rho^q}{q(1-\rho)}\right)}$$

Similarly, neglecting the idiosyncratic risk component can also lead to underestimates of their true volatility. Piazzesi and Schneider (2016) show that the idiosyncratic volatility of individual house prices is over twice as large as that of city-level indices. However, from the perspective of an institutional investor idiosyncratic risks are partially diversifiable.[15]. To account for this I multiply my annualized volatility measure constructed from house price and rental indices $avvol_n^a$ estimate by a scale factor $\eta = 1.5$. This choice of scale factor assumes that half of idiosyncratic risk is diversifiable and that the main source of risk is aggregate risk. If idiosyncratic risk were wholly undiversifiable the appropriate value to match the findings of Piazzesi and Schneider (2016) would be $\eta = 2$. Since this is a linear transformation the only effect this has on my results is a change in magnitude of my estimated coefficients, not their significance. Figure D.1 illustrates further that there is no relationship between expected excess returns and their volatility as would be expected if houses were priced by a Capital Asset Pricing Model, nor is there a relationship between activity of institutional investors and volatility.

[15]For example, tenant delinquency is likely correlated across properties due to its co-movement with the business cycle

Figure D.1: SFH Expected excess returns and volatility



E Appendix: Model

E.1 Household problem

Taking first order conditions for the household sector leads to household demand

$$x_{ht}^{H}(P_t^H) = \begin{cases} 0 & \text{if } \frac{\mathbb{E}_t^h[P_{t+1}^H]+(1+\nu)\delta_{t+1}^H}{R_{t+1}^f} \leq P_t^H \\ \frac{\mathbb{E}_t^h[P_{t+1}^H]+(1+\nu)\delta_{t+1}^H-(R_t^f+\psi_{ht})P_t^H}{A_h\sigma_H^2} & \text{if } \frac{\mathbb{E}_t^h[P_{t+1}^H]+(1+\nu)\delta_{t+1}^H}{R_{t+1}^f} > P_t^H \end{cases}$$

where ψ_{ht} denotes the shadow cost of the household funding constraint and is given by the expression

$$\psi_{ht}(P_t^H) = \begin{cases} \frac{1}{P_t^H}\left(\mathbb{E}_t^h\left[P_{t+1}^H\right] + (1+\nu)\delta_{t+1}^H - R_{t+1}^f P_t^H - \frac{A_h\sigma_H^2 w_{it}}{m_t^h P_t^H}\right) & \text{if } \underline{P}_t^H(\omega) < P_t^H < \overline{P}_t^H(\omega) \\ 0 & \text{else} \end{cases} \tag{9}$$

where

$$\underline{P}_t^H(\omega) \equiv \frac{\mathbb{E}_t^h\left[P_{t+1}^H\right]+(1+\nu)\delta_{t+1}^H}{2R_{t+1}^f} - \sqrt{\left(\frac{\mathbb{E}_t^h\left[P_{t+1}^H\right]+(1+\nu)\delta_{t+1}^H}{2R_{t+1}^f}\right)^2 - \frac{A_h\sigma_H^2\omega}{R_{t+1}^f m_t}}$$

$$\overline{P}_t^H(\omega) \equiv \frac{\mathbb{E}_t^h\left[P_{t+1}^H\right]+(1+\nu)\delta_{t+1}^H}{2R_{t+1}^f} + \sqrt{\left(\frac{\mathbb{E}_t^h\left[P_{t+1}^H\right]+(1+\nu)\delta_{t+1}^H}{2R_{t+1}^f}\right)^2 - \frac{A_h\sigma_H^2\omega}{R_{t+1}^f m_t}}$$

which allows to make the following statements about household demand

1. Representative household demand x_{ht}^H is (weakly) decreasing in margin requirements m_t^h and the risk free rate R_{t+1}^f , (weakly) increasing in wealth ω and non-pecuniary benefits of home ownership ν

2. Their funding constraint ψ_{ht} is (weakly) increasing in margin requirements m_t^h and the risk free rate R_{t+1}^f, (weakly) decreasing in wealth ω

E.2 Investor problem

The investor divides their wealth between the outside asset and homes with expected next period prices and dividends $\mathbb{E}_t^I\left[P_{t+1}^S\right], \mathbb{E}_t^I\left[P_{t+1}^H\right], \delta_t^S, (1-\tau)\delta^H$, where τ reflects the maintenance costs of operating rental properties. Aside differences in the value of rental cash flows and access to an outside asset, the investor has the same mean-variance objective function as households less their borrowing constraint.

Solving the investor's portfolio choice problem for general Ω leads to investor demand x_{It}^H, x_{It}^S

$$x_{It}^H, x_{It}^S = \begin{cases} 0, 0, & \text{if } RG_{It+1}^H < 0 \;\&\; RG_{It+1}^S < 0 \\ 0, \frac{RG_{It+1}^S}{A_I\sigma_S^2} & \text{if } \frac{\sigma_{HS}}{\sigma_S^2}\frac{RG_{It+1}^S}{RG_{It+1}^H} > 1 \;\&\; RG_{It+1}^S > 0 \\ \frac{RG_{It+1}^H}{A_I\sigma_H^2}, 0 & \text{if } \frac{\sigma_{HS}}{\sigma_H^2}\frac{RG_{It+1}^H}{RG_{It+1}^S} > 1 \;\&\; RG_{It+1}^H > 0 \\ \frac{\frac{RG_{It+1}^H}{A_I\sigma_H^2} - \frac{\sigma_{HS}}{\sigma_H^2}\frac{RG_{It+1}^S}{A_I\sigma_S^2}}{1-\frac{\sigma_{HS}^2}{\sigma_S^2\sigma_H^2}}, \frac{\frac{RG_{It+1}^S}{A_I\sigma_S^2} - \frac{\sigma_{HS}}{\sigma_S^2}\frac{RG_{It+1}^H}{A_I\sigma_H^2}}{1-\frac{\sigma_{HS}^2}{\sigma_S^2\sigma_H^2}} & \text{if } RG_{It+1}^H > \frac{\sigma_{HS}}{\sigma_S^2}RG_{It+1}^S \;\&\; RG_{It+1}^S > \frac{\sigma_{HS}}{\sigma_H^2}RG_{It+1}^H \end{cases}$$

where RG_{It}^i denotes

$$RG_{It+1}^S \equiv \mathbb{E}_t^I\left[P_{t+1}^S\right] + \delta_{t+1}^S - R_{t+1}^f P_t^S$$

$$RG_{It+1}^H \equiv \mathbb{E}_t^I\left[P_{t+1}^H\right] + (1-\tau)\delta_{t+1}^H - R_{t+1}^f P_t^H$$

which in the case of $\sigma_{HS} = 0$ simplifies to

$$x_{It}^H(P_t^H) = \begin{cases} 0 & \text{if } \frac{\mathbb{E}_t^I\left[P_{t+1}^H\right]+(1-\tau)\delta_{t+1}^H}{R_{t+1}^f} \leq P_t^H \\ \frac{\mathbb{E}_t^I\left[P_{t+1}^H\right]+(1-\tau)\delta_{t+1}^H - R_{t+1}^f P_t^H}{A_h\sigma_H^2} & \text{if } \frac{\mathbb{E}_t^I\left[P_{t+1}^H\right]+(1-\tau)\delta_{t+1}^H}{R_{t+1}^f} > P_t^H \end{cases}$$

$$x_{It}^H(P_t^H) = \begin{cases} 0 & \text{if } \frac{\mathbb{E}_t^I\left[P_{t+1}^H\right]+(1-\tau)\delta_{t+1}^H}{R_{t+1}^f} \leq P_t^H \\ \frac{\mathbb{E}_t^I\left[P_{t+1}^H\right]+(1-\tau)\delta_{t+1}^H - R_{t+1}^f P_t^H}{A_h\sigma_H^2} & \text{if } \frac{\mathbb{E}_t^I\left[P_{t+1}^H\right]+(1-\tau)\delta_{t+1}^H}{R_{t+1}^f} > P_t^H \end{cases}$$

E.3 Proofs

E.3.1 Proposition 1

If the investor owns no housing the markets for housing and the outside asset are segmented: Households own homes while investors own stocks. In this case it has to hold that house prices are determined solely by the households first order condition and equal to

$$P_t^H = \frac{\mathbb{E}_t^h\left[P_{t+1}^H\right] + (1+\nu)\delta_{t+1}^H - A_h\sigma_H^2 H^*}{R_{t+1}^f + \psi_{ht}}$$

Given the solution to the investor problem this implies that RG_{It+1}^H, determined by house prices set by households, needs to be sufficiently low that it is optimal for the investor to remain outside of the housing market.

$$RG_{It+1}^H = \mathbb{E}_t^I\left[P_{t+1}^H\right] + (1-\tau)\delta_{t+1}^H - R_{t+1}^f \frac{\mathbb{E}_t^h\left[P_{t+1}^H\right] + (1+\nu)\delta_{t+1}^H - A_h\sigma_H^2 H^*}{R_{t+1}^f + \psi_{ht}} < 0$$

Since RG_{It+1}^H is *increasing* in ψ_{ht}, the necessary condition for segmentation to occur can be determined by checking the investor's first order condition in the setting of an unconstrained household ($\psi_{ht} = 0$), which leads to the necessary condition for segmentation to occur in proposition 1

$$(\nu+\tau)\delta_{t+1}^H + \Delta_{hI}^H > A_h\sigma_H^2 H^* \tag{10}$$

If this condition is *not* satisfied, segmentation will never occur as the investor will always choose to hold some amount of housing. If the condition *is* satisfied, segmentation depends on

the household funding constraint ψ_{ht} given by equation (9).

E.3.2 Proposition 2

Conditional on the necessary condition for segmentation being satisfied,the sufficient condition for segmentation imposes an upper bound on the shadow cost of household margin constraints. Specifically, rearranging the equation above, ψ_{ht} needs to satisfy

$$\psi_{ht} < R^f_{t+1}\left[\frac{(\nu+\tau)\delta^H_{t+1} - \Delta^H_{Ih} - A_h\sigma^2_H H^*}{\mathbb{E}^I_t\left[P^H_{t+1}\right] + (1-\tau)\delta_{t+1}}\right] \tag{11}$$

Note that intuitively, if condition 1 is not satisfied, the right hand side is negative such that segmentation can never occur even if the household is unconstrained. The funding constraint ψ_{ht} is nonzero for values of P^H_t between $\underline{P}^H_t(\omega)$ and $\overline{P}^H_t(\omega)$. If the household is constrained and markets remain segmented household demand is sufficiently unconstrained such that their demand clears the housing market at prices

$$P^H_t = \frac{\omega^z_{ht}}{m^z_{ht}H^*}$$

which need to satisfy

$$\frac{\omega^z_{ht}}{m^z_{ht}} > \frac{H^*\left(\mathbb{E}^I_t\left[P^H_{t+1}\right] + (1-\tau)\delta^H_{t+1}\right)}{R^f_{t+1}} \tag{12}$$

in order for segmentation to occur based on the investor's first order condition.

Equivalently, rearranging the expression for the Lagrange multiplier on the funding constraint for prices in which the funding constraint binds $\underline{P}^H_t(\omega) < P^H_t < \overline{P}^H_t(\omega)$ leads to the same requirement for $\frac{\omega^z_{ht}}{m^z_{ht}}$:

$$\psi_{ht} = \frac{m^z_{ht}H^*}{\omega^z_{ht}}\left(\mathbb{E}^h_t\left[P^H_{t+1}\right] + (1+\nu)\delta^H_{t+1} - R^f_{t+1}\frac{\omega}{m^z_{ht}H^*} - A_h\sigma^2_H H^*\right) < R^f_{t+1}\left[\frac{(\nu+\tau)\delta^H_{t+1} - \Delta^H_{Ih} - A_h\sigma^2_H H^*}{\mathbb{E}^I_t\left[P^H_{t+1}\right] + (1-\tau)\delta_{t+1}}\right]$$

which requires that

$$\frac{\omega_{ht}^z}{m_{ht}^z} > \frac{H^* \left(\mathbb{E}_t^I \left[P_{t+1}^H\right] + (1-\tau)\delta_{t+1}^H\right)}{R_{t+1}^f}$$

which coincides with previous expression.

E.4 Nature of equilibrium

Propositions 1 and 2 allow to derive the nature of equilibrium. Provided that the necessary condition of proposition 1 (equation (10)) is satisfied, both pooling equilibria and a segmented equilibria exist, which is an assumption I make throughout this paper.

If the condition from proposition 2 (equation (12)) holds, house prices are determined by the household first order condition. Conversely, if (12) does not hold households are sufficiently funding constrained that segmentation breaks down and prices are determined by the joint demand of households and investors.

$$P_t^H = \begin{cases} \frac{\mathbb{E}_t^h[P_{t+1}^H]+(1+\nu)\delta_{t+1}-A_h\sigma_H^2 H^*}{R_{t+1}^f+\psi_{ht}} & \text{if (2) holds} \\ \frac{1}{R_{t+1}^f}\left(\frac{\mathbb{E}_t^I[P_{t+1}^H]+(1-\tau)\delta_{t+1}^H-A_I\sigma_H^2 H^*}{2} + \sqrt{\left(\frac{\mathbb{E}_t^I\left[P_{t+1}^H\right]+(1-\tau)\delta_{t+1}^H-A_I\sigma_H^2 H^*}{2}\right)^2 + \frac{\omega_{zt}^h R_{t+1}^f A_I\sigma_H^2}{m_{ht}^z}}\right) & \text{if (2) does not hold} \end{cases}$$

Intuitively, house prices are increasing in available household funds $\frac{\omega_{ht}^z}{m_{ht}^z}$ and determined solely by the investor first order condition if $\omega_{ht}^z = 0$. If equation (12) holds with equality, the price set by the household funding constraint coincides with the price at which the investor optimally chooses $x_{It}^H = 0$. Plugging in expressions for prices into the solution to the investor's problem yields a closed form expression for their position in housing.

$$x_{It+1} = \begin{cases} 0, & \text{if (2) holds} \\ \frac{\frac{\mathbb{E}_t^I[P_{t+1}^H]+(1-\tau)\delta_{t+1}^H+A_I\sigma_H^2 H^*}{2} - \sqrt{\left(\frac{\mathbb{E}_t^I\left[P_{t+1}^H\right]+(1-\tau)\delta_{t+1}^H-A_I\sigma_H^2 H^*}{2}\right)^2 + \frac{\omega_{zt}^h R_{t+1}^f A_I\sigma_H^2}{m_t^h}}}{A_I\sigma_H^2}, & \text{if (2) does not hold} \end{cases}$$

which confirms the predictions that the investor's housing position is increasing in the household's down-payment requirements m_t^h and decreasing in household wealth ω_{ht}^z and the risk-free

rate R^f_{t+1}. The corresponding positions of the household are given by

$$x^H_{ht+1} = \begin{cases} H^*, & \text{if (2) holds} \\ \dfrac{\omega^h_{zt} R^f_{t+1}}{m^h_t \left(\frac{\mathbb{E}^I_t\left[P_{t+1}\right] + (1-\tau)\delta^H_{t+1} - A_I \sigma^2_H H^*}{2} + \sqrt{\left(\frac{\mathbb{E}^I_t\left[P_{t+1}\right] + (1-\tau)\delta^H_{t+1} - A_I \sigma^2_H H^*}{2} \right)^2 + \frac{\omega R^f_{t+1} A_I \sigma^2_H}{m^h_t}} \right)}, & \text{if (2) does not hold} \end{cases}$$

and decreasing in the household down-payment requirement m^z_{ht} and increasing in household wealth ω^z_{ht}.

The derived expressions allow to re-express these equations in terms of expected excess returns.

E.4.1 Expected excess returns

The difference in valuation of rental cash flows drives a wedge between the expected excess returns of investors and households in the housing market. Investor's expected excess returns including operating costs are given by

$$\begin{aligned} RX^H_{It+1} &\equiv \mathbb{E}^I_t \left[\frac{P^H_{t+1} + (1-\tau)\delta^H_{t+1}}{P^H_t} - R^f_{t+1} \right] \\ &= \begin{cases} \dfrac{\psi_{ht}\left(\mathbb{E}^I_t\left[P^H_{t+1}\right] + (1-\tau)\delta^H_{t+1}\right) - R^f_{t+1}\left[(\tau+\nu)\delta^H_{t+1} - \Delta^H_{Ih} - A_h \sigma^2_H H^*\right]}{\mathbb{E}^h_t\left[P^H_{t+1}\right] + (1+\nu)\delta_{t+1} - A_h \sigma^2_H H^*}, & \text{if (2) holds} \\ \dfrac{R^f_{t+1}\left(\left[\mathbb{E}^I_t\left[P^H_{t+1}\right] + (1-\tau)\delta^H_{t+1}\right] A_I \sigma^2_H H^* - \frac{\omega^h_{zt} R^f_{t+1} A_I \sigma^2_H}{m^z_{ht}} \right)}{\left(\frac{\mathbb{E}^I_t\left[P^H_{t+1}\right] + (1-\tau)\delta^H_{t+1} - A_I \sigma^2_H H^*}{2} + \sqrt{\left(\frac{\mathbb{E}^I_t\left[P^H_{t+1}\right] + (1-\tau)\delta^H_{t+1} - A_I \sigma^2_H H^*}{2} \right)^2 + \frac{\omega^z_{ht} R^f_{t+1} A_I \sigma^2_H}{m^z_{ht}}} \right)^2} & \text{if (2) does not hold} \end{cases} \end{aligned}$$

while household's expected excess returns inclusive of non-pecuniary benefits are

$$\begin{aligned} RX^H_{ht+1} &\equiv \mathbb{E}^h_t \left[\frac{P^H_{t+1} + (1+\nu)\delta^H_{t+1}}{P^H_t} - R^f_{t+1} \right] \\ &= \begin{cases} \dfrac{\psi_{ht}\left(\mathbb{E}^h_t\left[P^H_{t+1}\right] + (1+\nu)\delta^H_{t+1}\right) + R^f_{t+1} A_h \sigma^2_H H^*}{\mathbb{E}^h_t\left[P^H_{t+1}\right] + (1+\nu)\delta_{t+1} - A_h \sigma^2_H H^*} & \text{if (2) holds} \\ \dfrac{R^f_{t+1}\left(\frac{\Delta^H_{hI} + (\nu+\tau)\delta^H_{t+1} + A_I \sigma^2_H H^*}{2} - \sqrt{\left(\frac{\mathbb{E}^I_t\left[P^H_{t+1}\right] + (1-\tau)\delta^H_{t+1} - A_I \sigma^2_H H^*}{2} \right)^2 + \frac{\omega^h_{zt} R^f_{t+1} A_I \sigma^2_H}{m^z_{ht}}} \right)}{\frac{\mathbb{E}^I_t\left[P^H_{t+1}\right] + (1-\tau)\delta^H_{t+1} - A_I \sigma^2_H H^*}{2} + \sqrt{\left(\frac{\mathbb{E}^I_t\left[P^H_{t+1}\right] + (1-\tau)\delta^H_{t+1} - A_I \sigma^2_H H^*}{2} \right)^2 + \frac{\omega^h_{zt} R^f_{t+1} A_I \sigma^2_H}{m^z_{ht}}}}, & \text{if (2) does not hold} \end{cases} \end{aligned}$$

Expected excess returns and housing volatility If households weren't funding constrained, expected excess returns in the cross-section of neighborhoods would be strictly increasing in volatility σ^2_H. Funding constraints can distort this relationship. If conditions (1) and (2) are satisfied, observe that the relationship between expected excess returns and volatility

obeys

$$\frac{\partial RX^H_{It+1}}{\partial \sigma^2_H} = \frac{\partial \left(\frac{\psi_{ht}\left(\mathbb{E}^I_t\left[P^H_{t+1}\right]+(1-\tau)\delta^H_{t+1}\right)}{\mathbb{E}^h_t\left[P^H_{t+1}\right]+(1+\nu)\delta_{t+1}-A_h\sigma^2_H H^*} \right)}{\partial \sigma^2_H} - \frac{\partial \left(\frac{R^f_{t+1}\left[(\tau+\nu)\delta^H_{t+1}-\Delta^H_{Ih}-A_h\sigma^2_H H^*\right]}{\mathbb{E}^h_t\left[P^H_{t+1}\right]+(1+\nu)\delta_{t+1}-A_h\sigma^2_H H^*} \right)}{\partial \sigma^2_H}$$

The first term is only present if the households' funding constraints bind and decreasing in volatility. The second term is strictly increasing in volatility and always present. Combining the two leads to

$$\frac{\partial RX^H_{It+1}}{\partial \sigma^2_H} = -\frac{R^f_{t+1} A_h H^* \left[\Delta^H_{hI} + (\nu+\tau)\delta^H_{t+1}\right]}{\left(\mathbb{E}^h_t\left[P^H_{t+1}\right] + (1+\nu)\delta_{t+1} - A_h\sigma^2_H H^*\right)^2} < 0$$

such that conditional on households being funding constrained the investors' expected excess returns are *decreasing* in volatility, as found in the data.

Expected excess returns on the outside asset In an extension that features non-zero correlation between the outside asset and housing the entry decision and its dependence on outside investment opportunities can be regulated through varying the supply of the outside asset S^*. To whit, the expected excess returns on the outside asset are determined solely by the investors preferences and expectations.

$$S^* = \frac{\mathbb{E}^I_t\left[P^S_{t+1}\right] + \delta^S_{t+1} - R^f_{t+1}P^S_t}{A_I\sigma^2_S}$$

$$P^S_t = \frac{\mathbb{E}^I_t\left[P^S_{t+1}\right] + \delta^S_{t+1} - A_I\sigma^2_S S^*}{R^f_{t+1}}$$

and their expected excess returns on the outside asset are

$$\mathbb{E}^I_t\left[\frac{P^S_{t+1}+\delta^S_{t+1}}{P^S_t} - R^f_{t+1}\right] = R^f_{t+1}\frac{A_I\sigma^2_S S^*}{\mathbb{E}^I_t\left[P^S_{t+1}\right] + \delta^S_{t+1} - A_I\sigma^2_S S^*}$$